

## American Burn Association Consensus Statements

Nicole S. Gibran, MD, FACS, Shelley Wiechman, PhD, ABPP, Walter Meyer, MD, Linda Edelman, RN, PhD, Jim Fauerbach, PhD, Linda Gibbons, RN, MS, Radha Holavanahalli, PhD, Carly Hunt, MA, Kelly Keller, RN, Elizabeth Kirk, MSN, APN, Jacqueline Laird, BSN, RN, Giavonni Lewis, MD, Sidonie Moses, RN, BSN, Jill Sproul, RN, MS, Gretta Wilkinson, RN, Steve Wolf, MD, FACS, Alan Young, DO, Sandra Yovino, RN, Michael J. Mosier, MD, Leopoldo C. Cancio, MD, Hamed Amani, MD, Carolyn Blayney, RN, Judith Cullinane, RN, MSN, CCRN, Linwood Haith, MD, James C. Jeng, MD, Patricia Kardos, RN, BSN, CCRN, George Kramer, PhD, Mary Beth Lawless, MS, RN, Maria L. Serio-Melvin, MSN, RN, Sidney Miller, MD, Katie Moran, RD, PA-C, Rachel Novakovic, MD, Bruce Potenza, MD, Anna Rinewalt, MD, John Schultz, MD, PhD, Howard Smith, MD, Maggie Dylewski, PhD, RD, Lucy Wibbenmeyer, MD, Palmer Q. Bessey, MD, FACS, Jennifer Carter, RD, Richard Gamelli, MD, FACS, Cleon Goodwin, MD, FACS, Tamara Graves, RN, BSN, Kathleen Hollowed, RN, Jimmy Holmes IV, MD, FACS, John Noordenbas, RN, Megan Nordlund, MS, RD, Alisa Savetamal, MD, Pegg Simpson, RN, Daniel Traber, PhD, Lillian Traber, RN, Bernadette Nedelec, PhD, BSc OT, Matthias Donelan, MD, FACS, Mary Jo Baryza, PT, MS, PCS, Dhaval Bhavsar, MD, Sigrid Blome-Eberwein, MD, Gretchen J. Carrougner, RN, MN, William Hickerson, MD, FACS, Victor Joe, MD, Marion Jordan, MD, FACS, Karen Kowalske, MD, Derek Murray, MSPT, BSBA, Vimal K. Murray, MD, FACS, Ingrid Parry, MS, PT, Michael Peck, MD, ScD, FACS, Debra Reilly, MD, Jeffrey C. Schneider, MD, Linda Ware, OT, CHT, Adam J. Singer, MD, Steven T. Boyce, PhD, David H. Ahrenholz, MD, Philip Chang, MD, Richard A. F. Clark, MD, PhD, Ryan Fey, MD, Phil Fidler, MD, Warren Garner, MD, David Greenhalgh, MD, Shari Honari, RN, BSN, Larry Jones, MD, Richard Kagan, MD, John Kirby, MD, Jeannie Leggett, RN, BSN, Nicholas Meyer, MD, Cynthia Reigart, RN, BSN, Karen Richey, RN, Lior Rosenberg, MD, Joan Weber, RN, BSN, CIC, Brad Wiggins, RN, BSN

## The ABA's Pursuit of Excellence: A Long and Winding Road...to Your Door

Nicole S. Gibran, MD, FACS\*

*\*From the University of Washington Medicine Regional Burn Center, University of Washington Medicine Department of Surgery, Seattle, Washington.*

*See under consensus statements for author affiliations.*

*The 2012 ABA burn quality consensus conference was underwritten in part by unrestricted educational grants from Molnlycke Health Care and Baxter Health Care.*

*Address correspondence to Nicole S. Gibran MD, FACS, UW Medicine Regional Burn Center, UW Medicine Department of Surgery, Seattle, Washington 98104.*

*Copyright © 2013 by the American Burn Association  
1559-047X/2013*

*DOI: 10.1097/BCR.0b013e31828cb249*

Quality is generally recognized to have three components: structure, process, and outcomes. The American Burn Association (ABA) has a long history of trying to improve quality of care for patients with burn injuries. Since its establishment by Dr. Irving Feller in the 1970s,<sup>1</sup> the National Burn Information Exchange, a nascent database relying on punch cards submitted by participating burn centers, has worked to drive quality improvement, regional healthcare planning, resource allocation, and research and

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE <b>01 JUL 2013</b>		2. REPORT TYPE <b>N/A</b>		3. DATES COVERED <b>-</b>	
4. TITLE AND SUBTITLE <b>American Burn Association consensus statements</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) <b>Gibran N. S., Wiechman S., Meyer W., Edelman L., Fauerbach J., Gibbons L., Holavanahalli R., Hunt C., Keller K., Kirk E., Laird J., Lewis G., Moses S., Sproul J., Wilkinson G., Wolf S., Young A., Yovino S., Mosier M. J., Cancio L. C., Amani H., Blayney C., Cullinane J., Haith L., Jeng J. C., Kardos P., Kramer G., Lawless M. B., Serio-Melvin M. L., Miller S., Moran K., Novakovic R., Potenza B., Rinewalt A., Schultz J., Smith H., Dylewski M., Wibbenmeyer L., Bessey P. Q., Carter J., Gamelli R., Goodwin C., Graves T., Hollowed K., Holmes IV J., Noordenbas J., Nordlund M., Savetamal A., Simpson P., Traber D., Traber L., Nedelec B., Donelan M., Baryza M. J., Bhavsar D., Blome-Eberwein S., Carrougner G. J., Hickerson W., Joe V., Jordan M., Kowalske K., Murray D., Murray V. K., Parry I., Peck M., Reilly D., Schneider J. C., Ware L., Singer A. J., Boyce S. T., Ahrenholz D. H., Chang P., Clark R. A., Fey R., Fidler P., Garner W., Greenhalgh D., Honari S., Jones L., Kagan R., Kirby J., Leggett J., Meyer N., Reigart C., Richey K., Rosenberg L., Weber J., Wiggins B.,</b>				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>United States Army Institute of Surgical Research, JBSA Fort Sam Houston, TX 78234</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release, distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>UU</b>	18. NUMBER OF PAGES <b>25</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

prevention. Over time, this project evolved into the voluntary ABA project, the National Burn Repository (NBR), which now reports on incidence, etiology, and acute outcomes. The 2011 NBR Summary Report included more than 160,000 submissions from burn centers in the United States and Canada (and in 2010, Sweden). Like all data repositories, it has imperfections including missing data fields, but the ABA has initiated measures to incorporate a validator to minimize inconsistent data.

A second ABA initiative was the Committee on Organization and Delivery of Burn Care project to establish quality indicators for burn outcomes. This culminated in a *Journal of Burn Care and Rehabilitation* publication<sup>2</sup> that acknowledged two types of standards: process (organizational) and practice (clinical goals). The authors also identified indicators, measures by which to evaluate progress.

In 2001, Dr. Jeffrey Saffle and colleagues published a series of Practice Guidelines for Burn Care in a supplement to the *Journal of Burn Care and Rehabilitation* ([http://www.ameriburn.org/resources\\_publications](http://www.ameriburn.org/resources_publications)). Because it was never listed in PubMed, it had limited circulation and access was restricted. Therefore, the Committee on Organization and Delivery of Burn Care revised a series of guidelines after 2006<sup>3</sup> and published them in the *Journal of Burn Care and Research*.

The culmination of the ABA's efforts to improve outcomes for patients with burn injuries has been the verification process, as outlined in the Guidelines for the Operation of Burn Centers, a chapter in the American College of Surgeons (ACS) Resources for Optimal Care of the Injured Patient ([http://www.facs.org/trauma/faq\\_answers.html](http://www.facs.org/trauma/faq_answers.html)). The verification process assesses process and emphasizes organizational infrastructure, including personnel qualifications, facility resources, and medical care services. This emphasis has been a great first step; but the verification stops short of assessing outcomes. In fact, examination of national repositories, including the University HealthSystem Consortium, the Centers for Medicare and Medicaid Services Hospital Compare Program (<http://hospitalcompare.hhs.gov/>), and the CDC National Health Safety Network (<http://www.cdc.gov/nhsn/dataStat.html>), has never demonstrated that verified burn centers have better outcomes. Furthermore, the Centers for Disease Control National Health Safety Network data suggest that compared with other intensive care units (ICUs), burn ICUs have significantly higher rates of catheter-associated blood stream infections, catheter-associated urinary tract infections, and ventilator-associated pneumonias in spite of many fewer catheters per 1000 hospital days and days of intubation.

Burn centers are valuable resources at significant risk because of increasing financial pressures. As healthcare dollars dwindle, burn centers will compete for increasingly limited healthcare funding. Other surgical specialties such as bariatrics have successfully linked specialty center accreditation with enhanced payment by benchmarking outcomes and demonstrating superior results. However, in spite of multiple attempts the burn community has never been able to link ABA verification with enhanced reimbursement. It is clear that to accomplish this goal, we must be able to link verification with improved outcomes, decreased mortality, shorter hospital stay, reduced hospital-acquired complications, improved functional recovery, return to work/school, cost containment, and resource optimization. Because the ACS National Surgery Quality Improvement Process metrics focus on elective surgical procedures and do not reflect injury severity or outcomes for patients with burns, inhalation injury, or large wounds, the burn community must develop criteria for quality of care in each of the domains that significantly impact our patients.

The National Quality Forum (<http://www.qualityforum.org>) identifies three main benefits to measuring outcomes:

1. Measures drive improvement, as evidenced by the fact that healthcare providers who review performance measures can adjust care, share successes, and probe for causes.
2. Measures inform consumers, as evidenced by the fact that consumers consult national resources such as HospitalCompare.hhs.gov to assess quality of care, make choices, ask questions, and advocate for good health care.
3. Measures influence payment, as evidenced by the fact that payers use measures as preconditions for payment and targets for bonuses, whether it is paying providers for performance or instituting nonpayment for hospital-acquired complications.

With the increasing national focus on quality metrics, the burn community must tackle how to move forward by establishing new burn-specific metrics beyond our traditional outcomes measures of survival and length of hospital stay. Just as the trauma community has created the Trauma Quality Improvement Program it may be time for the burn community to create Burn Quality Improvement Program (BQIP). Because hospitals focus on metrics to improve standings, the burn community needs burn-specific patient-safety data. The NBR, which currently reports incidence, etiology, and acute outcomes, could easily be adapted to include quality data. A revised NBR could include hospital-acquired conditions that

hospitals already upload to national administrative repositories. A next step could be to include long-term measures of recovery including functional, psychological, and vocational status. Eventually, it may be appropriate to record patients' experiences, just as reported in publically accessible CMS databases such as <http://hospitalcompare.hhs.gov>. Like all data repositories, the NBR has imperfections including missing data fields. However, measures by the ABA Burn Registry and NBR Advisory committees to work with Digital Innovation, Inc. (Forest Hill, MD) to incorporate a validator should minimize inconsistent data.

To initiate this project, the ABA convened a consensus symposium in February 2012 to define burn-specific outcomes in five areas: functional outcomes, nutrition, psychological outcomes, resuscitation, and wound repair. After reviewing the literature, debating the issues at the consensus conference and providing opportunities for feedback from the burn community at an open forum at the 2012 annual meeting of the ABA and on an ABA-sponsored Web site, the consensus panels devised recommended metrics that could be tracked locally or as part of the NBR. These have been written as white papers and are published here in the *Journal of Burn Care and Research*.

Our plan will be to incorporate these quality outcomes indicators into a revised Web-based NBR. The distinction between this new platform and the existing national databases will be the ability to stratify data

according to burn patient injury severity, with a focus on burn-specific injury characteristics including burn size, site, and inhalation injury. Once this platform has been built, a pilot study with 15 to 20 verified burn centers for adult and pediatric patients will beta test the data collection and reporting system to determine relevance of the metrics. The ABA will then introduce this as a new BQIP to augment our current TRACS system. The expectation will be for burn directors to perform quarterly analysis of their benchmarks to assess their performance compared with a national average to drive improvement in clinical care and to identify gaps in knowledge. Eventually, demonstration of such process improvement initiatives using the ABA BQIP data repository will be necessary for ABA/ACS verification.

Establishing benchmarks for important quality outcomes relevant to burn patients may finally allow us to follow the ACS program in bariatric surgery and link quality-based purchasing with verification. For this collaborative project to succeed, the burn community will need to understand the need and embrace the effort.

## REFERENCES

1. Helvig EI, Upright J, Bartleson BJ, Kagan RJ. Development of burn outcomes and quality indicators. A project of the ABA Committee on Organization and Delivery of Burn Care. *J Burn Care Rehabil* 1995;16(2 Pt 2):208-11.
2. Gibran NS; Committee on Organization and Delivery of Burn Care, American Burn Association. Practice Guidelines for burn care, 2006. *J Burn Care Res* 2006;27:437-8.

## Psychological Outcomes

Shelley Wiechman, PhD, ABPP,\* Walter Meyer, MD,† Linda Edelman, RN, PhD,‡  
Jim Fauerbach, PhD,§ Linda Gibbons, RN, MS, Radha Holavanahalli, PhD,||  
Carly Hunt, MA,§ Kelly Keller, RN,¶ Elizabeth Kirk, MSN, APN,#  
Jacqueline Laird, BSN, RN,\*\* Giavonni Lewis, MD,‡ Sidonie Moses, RN, BSN,††  
Jill Sproul, RN, MS,‡‡ Gretta Wilkinson, RN, Steve Wolf, MD, FACS,||  
Alan Young, DO,§§ Sandra Yovino, RN||||

From the \*University of Washington/Harborview Medical Center, Seattle; †University of Texas Medical Branch, Galveston; ‡University of Utah, Salt Lake City; §Johns Hopkins University School of Medicine, Baltimore, Maryland; ||University of Texas Southwestern, Dallas; ¶Ohio State University Medical Center, Mansfield; #Arkansas Children's Hospital, Little Rock; \*\*Bridgeport Hospital, Connecticut; ††University of Kansas Hospital; ‡‡Santa Clara Valley Medical Center, San Jose, California; §§US Army Institute of Surgical Research, Fort Sam Houston, Texas; and ||||Leon S. Peters Burn Center, Fresno, California.  
Address correspondence to Shelley A. Wiechman, PhD, ABPP, University of Washington Burn Center, Harborview Medical Center, 325 Ninth Avenue, Box 359740, Seattle, Washington 98104.

The purpose of the Psychological Outcomes Consensus Committee was to establish quality metrics for psychological outcomes after burn injuries. We were charged with reviewing the literature and critically evaluating evidence for the use of screening measures and standardized assessment tools, with the goal of establishing evidence-based practice guidelines for adults and children across the recovery continuum for both clinical and research purposes. We focused on metrics for depressive symptoms and symptoms of

both acute stress disorder (ASD) and posttraumatic stress disorder (PTSD). The committee chose to focus on these three disorders, based on prevalence and the impact that symptoms have on other aspects of burn care and quality of life. Our multidisciplinary committee was sensitive to the fact that many burn centers do not have a dedicated mental health professional on the team who routinely screens for these disorders and that screening will likely be done by a bedside nurse, a clinic nurse, or possibly a social worker. Although the committee expects burn centers to make appropriate referrals to mental health professionals for treatment if indicated, our charge did not include specific treatment guidelines. The taskforce determined that there are insufficient data on both screening and assessment tools in the burn population to advocate for the use of specific measures; because standard tables of evidence could not be created, we listed commonly used measures with their characteristics to guide burn team choice of measures. It is likely that screening for psychological disorders will eventually affect reimbursement, and proactively setting the standards for appropriate screening for patients with burn injuries is essential.

## DEPRESSION

### Definition

Major depressive disorder (MDD) is a clinical diagnosis based primarily on subjective, self-reported symptoms, evaluated with respect to intensity, duration, and impact on daily functioning. The Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV)<sup>1</sup> defines disorders including MDD based on the presence of a minimum number of symptoms or features.<sup>2</sup> The diagnosis of MDD requires the presence of five of nine psychological and somatic symptoms and must include at least one of the two essential criteria, depressed mood or loss of interest or pleasure (anhedonia). The symptoms must be consistently present for at least 2 weeks and cause clinically significant impairment in daily functioning. See the DSM-IV<sup>1</sup> for criteria for MDD. It is important to note that even if a person does not meet criteria for a diagnosis of MDD, depressive symptoms can be debilitating, interfere with care, and therefore warrant treatment.

### How It Meets Clinical Care Quality Outcomes

Depressive symptoms are one of the most commonly reported psychological problems after a burn injury. Frequency rates of depressive symptoms within the first year after injury vary widely depending upon the measure used and the definition of depressive

symptomatology vs a DSM-IV diagnosis of depression. Rates range from about 4% at discharge to 10 to 23% 1 year postinjury,<sup>3-5</sup> with increasing prevalence after discharge through the first year. Whereas no current measures specifically address depression in patients with burn injuries, it is unclear whether burn-specific measures are actually needed. In fact, the taskforce cautions against the development of new depression measures for this population until the inadequacy of existing measures is well established; instead, we encourage efforts to validate existing measures that have been shown to be valid and reliable across other medical and general populations. Validation of the existing general measures of depression for the population of burn survivors may provide greater understanding of depression after burn injury and allow comparison across other patient populations. Individual symptoms of depression can be debilitating and interfere with treatment, and one of the first signs of depression in a medical setting (inpatient or outpatient) is refusal to participate in prescribed therapies. Therefore, if symptoms of depression interfere with patient ability to get better (eg, adherence to therapies, withdrawal), then the symptoms should be treated, even without a formal diagnosis.

### Proposed Metrics for the TRACS Database

Review of evidence-based literature supports the use of three measures for depression (Table 1).

1. Beck Depression Inventory-II<sup>6</sup>
2. Hospital Anxiety Depression Scale<sup>7</sup>
3. Brief Symptom Inventory<sup>8</sup>

However, these lengthy instruments must be purchased and should be administered by a trained mental health professional, which creates potential barriers for most burn units.

The committee was encouraged by the widespread use of the Patient Health Questionnaire (PHQ)-9 item<sup>9</sup> and especially the PHQ-2 item (first two items of the PHQ-9) in other hospital-based populations. This measure is also gaining popularity for researchers. Therefore, we recommend the use of this measure for inpatient and outpatient screening. Given the sensitivity of the PHQ-2, the administration of these two simple questions by a bedside intensive care unit (ICU), acute care or clinic nurse may provide the most practical screening option for all three settings. Positive indicators of depressive symptoms on the screening tools warrant referral to a mental health professional to thoroughly diagnose MDD and to make treatment recommendations. The mental health professional might then consider use of one of the measures that have been validated in the



**Table 1.** Summary of recommended depression measures

Measure	Reference	Items	Time, min	Cost	Setting	Age
PHQ-2 or 9	Spitzer et al (1999) <sup>9</sup>	9	3	Free	Inpatient or outpatient Research or clinical	Adult
Beck Depression Inventory-II	Beck et al (1996) <sup>6</sup>	21	5	Fee	Outpatient Research or clinical diagnostic by a mental health professional	Adult
Hospital Anxiety and Depression Scale	Zigmond and Snaith (1983) <sup>7</sup>	14	2–5	Fee	Outpatient Research or clinical diagnostic by a mental health professional	Adult
Brief Symptom Inventory	Derogatis (1975) <sup>8</sup>	53	8–12	Fee	Outpatient research or clinical screen	Adult
Child Depression Inventory (short form)	Kovacs (1992) <sup>11</sup>	10	5	Fee	Inpatient or outpatient Research or clinical diagnostic by a mental health professional	Children and adolescents
Achenbach Child Behavior Checklist	Achenbach and Rescorla (2001) <sup>10</sup>	118	15	Fee	Outpatient Research or clinical diagnostic by a mental health professional	Children and adolescents

PHQ, Patient Health Questionnaire.

burn population to complete their assessment. The committee recommends three questions to screen for depressive symptoms: The first question is posed to the treatment team and is an important behavioral observation: “Is the patient refusing treatment regularly?” The next two questions are asked of the patient: “Do you feel sad or tearful for most of the day, every day?” and “Do you have little interest or pleasure in doing things?”

The committee found no validated screening tools for depression in children with burn injuries. The Achenbach Child Behavior Checklist<sup>10</sup> is widely used for research and in outpatient settings for young burn survivors, but its use as an inpatient screening tool is not practical. In the ICU and acute care settings, behavioral indicators may be the most accurate and practical assessment of mood in children. Therefore, we recommend the following screening be assessed by a member of the medical team: 1) frequent tearfulness; 2) withdrawal or refusal to participate in therapies; 3) agitation. The presence of these behaviors warrants a referral to a mental health professional. In the acute and outpatient setting, the Child Depression Inventory<sup>11</sup> seems to be the best option; a downside is that it does need to be purchased and administered by a mental health practitioner.

The committee recommends that all inpatients be screened for depressive symptoms within 48 hours of accessibility (eg, mental status clears) and at least one time before discharge. All outpatients should be screened at their first clinic visit after discharge and as indicated thereafter.

By including psychological metrics in the National Trauma Registry of the American College of Surgeons

(TRACS) database, the committee anticipates a better understanding of the overall prevalence of depression among patients with burn injuries. The proposed variables to be entered into TRACS for both adult and children include:

1. Was the patient screened for depression? (yes/no)
2. Was the screen positive? (yes/no)
3. Was a referral to a mental health provider made? (yes/no)
4. Was there a diagnosis of MDD? (yes/no)

As with depression, the following variables should be added to the NTRACS database:

1. Was the patient screened for ASD/PTSD? (yes/no)
2. Was the screen positive? (yes/no)
3. Was a referral to a mental health provider made? (yes/no)
4. Was there a diagnosis of ASD/PTSD? (yes/no)

## Opportunities for Research

Our review identifies the need for standard guidelines to assess depression and validation of existing measures of depression for the burn population to more accurately determine rates of depression and evaluate treatment. Clearly, the burn community must rigorously evaluate the depression measures used in the small existing body of research on depression and burn injury. In order to accomplish this, researchers must report psychometric properties of measures in their studies to validate existing measures of depression for the burn population. The committee felt

that identification of a standard set of psychological outcome measures used across funding agencies would provide great potential benefit to understanding psychological responses after burn injuries. For example, groups participating in multicenter clinical trials, such as the National Institute on Disability and Rehabilitation Research (NIDRR)-funded Burn Model Systems and the Burn Science Advisory Panel could consider adopting the same evidence-based psychological outcome measures. Further, adoption of more widely used measures would allow comparison with patient populations with other disabilities.

### Recommended Depression Measures

	Inpatient	Outpatient	Research
Adults	PHQ-2 (Screening)	PHQ-2 (screening)	SCID (gold standard)
	BDI-II (diagnosis/severity)	PHQ-9 (diagnosis/severity)	PHQ-9
	HADS (diagnosis/severity)	BDI-II	BDI-II
		BSI	HADS BSI
Children	Behavioral indicators (screening):	Behavioral indicators (screening):	Diagnostic interview:
	frequent tearfulness,	frequent tearfulness,	Achenbach
	withdrawal, refusal to participate in therapies	withdrawal, refusal to participate in therapies	Child Behavior Checklist
		Child Depression Inventory	
		(diagnosis/severity)	

*PHQ*, Patient Health Questionnaire; *SCID*, structured clinical interview; *BDI*, Beck Depression Inventory; *HADS*, Hospital Anxiety Depression Scale; *BSI*, Brief Symptom Inventory.

## ACUTE STRESS DISORDER/ POSTTRAUMATIC STRESS DISORDER

### Definition

One of the most distressing psychological problems associated with a burn injury is ASD and its subsequent form, PTSD. Both of these disorders are associated with poorer physical and social function and greater psychosocial distress.<sup>12</sup> The full diagnostic criteria for both disorders can be found in the DSM-IV Manual.<sup>1</sup> Briefly, a person must have been exposed to a traumatic event and have subsequent episodes of reexperiencing the event (nightmares or flashbacks), symptoms of avoidance, and symptoms of hypervigilance. He or she may also experience numbing or dissociation. Symptoms occurring in the first month after the traumatic event constitute ASD; thereafter it is PTSD. When ASD symptoms occur early in the

burn management they can result in agitation and disrupt normal medical care.

### How It Meets Clinical Care Quality Outcomes

The burn survivor has a great risk for ASD and PTSD because his or her trauma occurs both in the accident and in the ongoing daily treatment of the burn wound. The prevalence of ASD in the burn survivor ranges from 6 to 33% regardless of the type of trauma.<sup>13</sup> PTSD is even more common, with rates of 24 to 40% at 6 months postinjury to 15 to 45% at 12 months postinjury. Studies of children suggest lower rates of 2 to 19% for current PTSD and 30% some time during the lifetime. The variability in reported rates reinforces the problem with use of different measurement tools and nonstandard sampling characteristics. ASD does not always lead to PTSD, but its presence is one of the strongest predictors of PTSD. The presence of ASD or PTSD symptoms can cause a disruption in clinical care, by interfering with a patient's ability to participate in therapies, prolonging delirium, and increasing the need for physical and chemical restraints. ASD is often misdiagnosed as agitation or psychosis and can lead to the overuse of sedation and pain medications. In the outpatient setting, PTSD can interfere with both physical therapies and patient ability to return to work/school. PTSD has also been found to lead to depression and sometimes suicide. As with depression, even if a person does not meet full criteria for a formal diagnosis, ASD/PTSD symptoms can be debilitating and should be treated. The committee recommends screening for ASD/PTSD in both the inpatient and outpatient settings and a referral to a mental health professional for a positive screen.

ASD/PTSD screening tools (Table 2) have been developed for use in large populations in a busy setting where long interviews are not practical. One screening tool, developed for ASD after burn injuries<sup>14</sup> provides a checklist based on DSM-IV criteria and is easy to use in the ICU setting. The Department of Veterans Affairs National Center for PTSD Web site (<http://www.ptsd.va.gov/professional/pages/assessments/child-trauma-ptsd.asp>) provides a broad overview of all the possible ASD/PTSD tools.

### Recommended ASD/PTSD Measures

In forming a recommendation, the consensus committee considered ease of administration, cost, and widespread use among other disability populations. The PTSD Symptom Checklist-Civilian version has garnered popularity for its psychometric properties, ease of use, and free availability in the public domain. Other disability groups, such as the NIDRR-funded

	Inpatient	Outpatient	Research
Adults	ASD screen, <sup>14</sup> as well as behavioral indicators such as sleep problems and agitation	PCL-C SPAN	PCL-C Davidson Trauma Scale
Children	ASD screen, <sup>14</sup> as well as behavioral indicators such as sleep problems and agitation	UCLA PTSD Index	UCLA PTSD Index Diagnostic Interview for Children

ASD, acute stress disorder; PCL-C, PTSD Symptom Checklist-Civilian version; SPAN, Startle, physiological Arousal, Anger, Numbness; PTSD, posttraumatic stress disorder.

Traumatic Brain Injury Model Systems and the Spinal Cord Injury Model Systems, have also adopted this tool to assess those patient populations.

Opportunities for Research

Again, the gold standard for assessing PTSD in clinical research is the diagnostic interview (eg, SCID). If this is not feasible, there is good evidence for the PTSD Symptom Checklist-Civilian version, the Davidson Trauma Scale, and the UCLA PTSD Index. As with depression, the consensus committee cautions against developing new measures of ASD or PTSD specifically for the burn population and endorses validating existing measures for this population, which will require researchers to report psychometric properties of the measures used for their studies. Collaboration among researchers in large multicenter clinical trials and model systems would allow for larger sample sizes and comparisons across disability groups. Finally, the committee felt that research aimed at preventing the onset of PTSD with the inhibition of encoding traumatic memories by

administering certain medications (eg, propranolol, morphine, sertraline)<sup>13,15,16</sup> should be a research priority. Improved pain management has also been suggested as a mechanism to prevent the onset of ASD/PTSD symptoms, and warrants a multicenter trial.

What Are the Potential Effects on Reimbursement or Hospital Costs?

In order to demonstrate that the multidisciplinary burn community addresses long-term needs of burn patients, burn centers should demonstrate that they screen for the two most common posttraumatic psychological disturbances, depression, and ASD/PTSD, and that they have a mechanism for referring patients for treatment who screen positive on the screening measure. Recently, the Medicare Provider Quality Reporting System has suggested that medical providers must screen for a minimum of three disorders in order to receive full reimbursement. They have provided a list of several potential disorders to screen for during inpatient and outpatient care. Disorders most relevant to psychological outcomes include depression, pain, alcohol abuse, and tobacco use. At this point, Provider Quality Reporting System is offering a 1% incentive when providers screen for a minimum of three disorders. Eventually, providers will be penalized if they do not screen for a minimum number of disorders.

SUMMARY AND RECOMMENDATIONS

1. All inpatients should be screened for depressive and ASD symptoms within 48 hours of accessibility (eg, delirium cleared) at least once before discharge
2. All outpatients should be screened for depressive and ASD/PTSD symptoms at their first clinic visit after discharge and as indicated thereafter
3. Verified burn centers should demonstrate that they have a referral process in place for an appropriate intervention by a licensed mental health

Table 2. Summary of recommended ASD/PTSD measures

Measure	Reference	Items	Time, min	Cost	Setting	Age
PCL	Weathers et al (1993) <sup>17</sup>	17	5–10	Free	Inpatient or outpatient Clinical or research	Adult
SPAN	Meltzer-Brody et al (1999) <sup>18</sup>	4	2		Outpatient Clinical	Adult
SCID	First et al (1996) <sup>19</sup>	21	30		Research	Adult
Davidson Trauma Scale	Davidson et al (1997) <sup>20</sup>	17	12		Research	Adult
UCLA PTSD Index	Pynoos et al (1998) <sup>21</sup>	48	20	Free	Outpatient Clinical or research	Child

ASD, acute stress disorder; PCL, PTSD checklist; PTSD, posttraumatic stress disorder; SCID, structured clinical interview.



practitioner should the patient screen positive for depressive, ASD, or PTSD symptoms

## REFERENCES

1. American Psychiatric Association TFO-D-I. Diagnostic and statistical manual of mental disorders-DSM-IV-TR. 4th revised ed. Washington, DC: American Psychiatric Association; 2000.
2. Zimmerman M, Chelminski I, McGlinchey JB, Young D. Diagnosing major depressive disorder VI: performance of an objective test as a diagnostic criterion. *J Nerv Ment Dis* 2006;194:565-9.
3. Fauerbach JA, Lawrence J, Haythornthwaite J, et al. Pre-burn psychiatric history affects posttrauma morbidity. *Psychosomatics* 1997;38:374-85.
4. Fukunishi I. Relationship of cosmetic disfigurement to the severity of posttraumatic stress disorder in burn injury or digital amputation. *Psychother Psychosom* 1999;68:82-6.
5. Tedstone JE, Tarrier N. An investigation of the prevalence of psychological morbidity in burn-injured patients. *Burns* 1997;23:550-4.
6. Beck AT, Steer RA, Brown GK. Manual for the Beck Depression Inventory-II. San Antonio, TX: Psychological Corporation; 1996.
7. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr Scand* 1983;67:361-70.
8. Derogatis LR. Brief symptom inventory. Baltimore, MD: Clinical Psychometric Research; 1975.
9. Spitzer RL, Kroenke K, Williams JB. Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. *Primary Care Evaluation of Mental Disorders. Patient Health Questionnaire*. *JAMA* 1999;282:1737-44.
10. Achenbach TM, Rescorla LA. Manual for the SEBA school-age forms & profiles. Burlington, VT: University of Vermont, Research Center for Children, Youth & Families; 2001.
11. Kovacs M. Children's depression inventory manual. North Tonawanda, NY: Multi-Health Systems, Inc.; 1992.
12. Corry NH, Klick B, Fauerbach JA. Posttraumatic stress disorder and pain impact functioning and disability after major burn injury. *J Burn Care Res* 2010;31:13-5.
13. Saxe GN, Stoddard F, Hall E, et al. Pathways to PTSD, part I: children with burns. *Am J Psychiatry* 2005;162:1299-304.
14. Robert R, Meyer WJ 3rd, Villarreal C, Blakeney PE, De-sai M, Herndon D. An approach to the timely treatment of acute stress disorder. *J Burn Care Rehabil* 1999;20:250-8.
15. McGhee LL, Slater TM, Garza TH, Fowler M, DeSocio PA, Maani CV. The relationship of early pain scores and post-traumatic stress disorder in burned soldiers. *J Burn Care Res* 2011;32:46-1.
16. Stoddard FJ Jr, Sorrentino EA, Ceranoglu TA, et al. Preliminary evidence for the effects of morphine on posttraumatic stress disorder symptoms in one- to four-year-olds with burns. *J Burn Care Res* 2009;30:836-43.
17. Weathers FW, Litz BT, Herman DS, Huskas JA, Keane TM. The PTSD checklist reliability, validity and diagnostic utility. Paper presented at the Annual Meeting of the International Society for Traumatic Stress Studies, San Antonio, TX, October, 1993.
18. Meltzer-Brody S, Churchill E, Davidson JRT. Derivation of the SPAN, a brief diagnostic screening test for post-traumatic stress disorder. *Psych Res* 1999;88:63-70.
19. First MB, Spitzer RL, Gibbon M, Williams, JB. Structured Clinical Interview for the DSM-IV Axis I Disorders. U.S. Department of Veterans Affairs, 1996.
20. Davidson JRT, Book SW, Colket JT, Tupler LA, Roth S, Hertzberg M, Mellman T, Beckham JC, Smith RD, Davidson RM, Katz R, Feldman ME. Assessment of a new self-rating scale for post-traumatic stress disorder. *Psych Med* 1997;27:143-60.
21. Pynoos RS, Goenjian AK, Steinberg AM. A public mental health approach to the postdisaster treatment of children and adolescents. *Child Adolesc Psychiatr Clin N Am*. 1998;7:195-210, x. Review.

## Burn Resuscitation

Michael J. Mosier, MD,\* Leopoldo C. Cancio, MD,† Hamed Amani, MD,‡ Carolyn Blayney, RN,§ Judith Cullinane, RN, MSN, CCRN,|| Linwood Haith, MD,¶ James C. Jeng, MD,# Patricia Kardos, RN, BSN, CCRN,\*\* George Kramer, PhD,†† Mary Beth Lawless, MS, RN,‡‡ Maria L. Serio-Melvin, MSN, RN,§§ Sidney Miller, MD,|| Katie Moran, RD, PA-C,¶¶ Rachel Novakovic, MD,## Bruce Potenza, MD,\*\*\* Anna Rinewalt, MD,††† John Schultz, MD, PhD,§§ Howard Smith, MD‡‡‡

From the \*Department of Surgery, Loyola Burn Center, Loyola University Medical Center, Maywood, Illinois; †U.S. Army Institute of Surgical Research, Fort Sam Houston, Texas; ‡Lehigh Valley, Allentown, Pennsylvania; §Harborview Medical Center, Seattle, Washington; ||Shriners' Hospital for Children Boston; ¶Nathan Speare Regional Burn Treatment Center, Upland, Pennsylvania; #The Burn Center at Washington Hospital, District of Columbia; \*\*Arizona Burn Center, Phoenix; ††University of Texas Medical Branch, Galveston; ‡‡University of California Davis Regional Burn Center, Sacramento; §§U.S. Army Institute of Surgical Research, Fort Sam Houston, Texas; |||Ohio State Medical Center, Columbus; ¶¶Bridgeport Hospital, Connecticut; ##Mercy St. Vincent Medical Center, Toledo, Ohio

\*\*\*University of California San Diego Regional Burn Center; †††Arkansas Children's Hospital, Little Rock; and ##Orlando Regional Healthcare System, Orlando, Florida.

The opinions or assertions contained herein are the private views of the authors, and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense. L. Cancio and G. Kramer are coinventors of Burn Resuscitation Decision Support Software (BRDSS). L. Cancio has assigned his rights to the Army.

Address correspondence to Michael Mosier, MD, FACS, Loyola University Medical Center, 2160 S. First Avenue, Maywood, Illinois 60153.

Fluid resuscitation remains the foundation of the early management of the burn-injured patient. Over the last 70 years more than a dozen widely used formulas have been advocated to treat the altered pathophysiology of burn shock, which includes both hypovolemic and cellular shock with hemodynamic challenges, decreased cardiac output, increased extracellular fluid, decreased plasma volume, and oliguria. The primary goal of resuscitation remains restoration and preservation of tissue perfusion in order to avoid ischemia and worsening of tissue injury. Burn wound edema, transvascular fluid shifts, and an increase in total body capillary permeability is exemplified by burn injury. Changes in the microvasculature caused by direct thermal injury and to inflammatory responses disrupt the normal capillary barrier that separates intravascular and interstitial compartments, and leads to rapid equilibration between compartments. This results in severe plasma volume depletion, increased extracellular fluid, and intravascular hypovolemia.

The Parkland formula (4 ml/kg/%TBSA) and modified Brooke formula (2 ml/kg/%TBSA) are the two most widely used resuscitation formulas.<sup>1</sup> Both formulas originally prescribed colloid administration over the second 24 hours, though many centers have abandoned this practice. In many cases these formulas have served merely as guidelines, as many authors have reported that they significantly underestimate actual fluid requirements. There is general agreement that there is an increasing tendency to over-resuscitate during burn shock.<sup>2-4</sup> To date, one of the unanswered questions in burn resuscitation is: what is the optimal use of colloids,<sup>5,6</sup> hypertonic saline,<sup>7</sup> and antioxidants?<sup>8</sup> Additionally, appropriate timing and use of treatments such as vasoactive agents,<sup>9</sup> renal replacement therapy (including high-volume hemofiltration),<sup>9,10</sup> and plasma exchange<sup>11</sup> require further study. Questions remain about what constitutes optimal monitoring of resuscitation, optimal resuscitation endpoints, and use and implementation of nursing<sup>12</sup> or computer-driven resuscitation protocols<sup>13</sup> to improve precision in resuscitation. In this environment, the Resuscitation Consensus Panel of the American Burn Association Quality Consensus Conference has been charged with identifying quality indicators for burn resuscitation.

This review led to the conclusion that there is insufficient evidence to support a resuscitation treatment standard at this time, and there is no common or nationally recognized benchmark at this time. Exploring processes across centers will help identify best practices and provide feedback regarding how high-performing centers separate themselves with respect to burn resuscitation.

The Consensus Panel reached the consensus that successful fluid resuscitation of a burn patient should occur within a 72-hour period after burn injury and use of the 72-hour marker will offer an outcome parameter that can be qualitatively assessed. Additionally, the group also agreed that there is a need to collect multicenter data to evaluate whether the attainment of a successful resuscitation could be reached at 24, 48, or 72 hours among patients with a burn size  $\geq 20\%$  TBSA. Analysis of the collected data may allow establishment of more comprehensive outcome parameters, providing the means for developing distinct quality indicators that could be used to differentiate successful fluid resuscitation from unsuccessful resuscitation. Recognizing that some patients with burns less than 20% TBSA may require or receive resuscitation, the Consensus Panel chose to recommend initial data collection to those patients with  $\geq 20\%$  TBSA burn to provide cleaner data for analysis. Additionally, differences between adult and pediatric patients could be further analyzed in subgroup analysis. Recommendations have been proposed under three categories:

1. Specialized care to burn patients
2. Preservation of vital organs
3. Preservation of life and quality of life

## SPECIALIZED CARE TO BURN PATIENTS

### How It Meets Clinical Care Quality Outcomes

Provision of specialized care to a burn patient that sustains, protects, and rehabilitates within the acute phase of injury represents a burn unit priority. Specialized care in the context of an environment (verified or self-defined burn center) should provide real-time monitoring of vital parameters as well as rapid intervention when necessary. Morbidity or consequences that lead to further deterioration, such as development of compartment syndromes, acute kidney injury, pulmonary edema, pneumothorax, and the acute respiratory distress syndrome, serve as markers for negative outcome. These morbidities arise from three potential system failures that serve as areas for quality improvement strategies: chance, fault within the system, or human error. Examples of system failures include overuse, underuse, or inappropriate use of resources (eg, too much fluid, too little fluid, or wrong fluid).

### Proposed Metrics To Be Added to the TRACS Database

Because of the fact that provision of specialized care of a burn patient that will sustain, protect, and

rehabilitate in the acute phase of injury is a priority in the burn unit, processes to provide this care should be monitored. The proposed outcome measures are:

1. Whether resuscitation was facilitated by use of a protocol or computer decision support.
2. Whether burned surface area was calculated by use of a Lund-Browder diagram or electronic program.
3. What formula or method was used to determine starting fluid rate and what urine output was targeted.

### Opportunities for Research Because of Lack of Level 1 Evidence

The Consensus Panel has identified opportunities for research in of processes and delivery of care and the perceived or potential benefit to protocols, establishing goals of care, and targeting endpoints of resuscitation.

## PRESERVATION OF VITAL ORGANS

### How It Meets Clinical Care Quality Outcomes

Preservation of vital organ function at the least physiologic cost and the least number of complications is the simplified goal of fluid resuscitation. The amount of fluid administered should be enough to maintain vital organ function without producing iatrogenic pathologic changes. Markers of a negative outcome, which could be used in this domain, may be those values that determine whether successful perfusion to tissue has been maintained, such as base deficit and lactate, as well as markers of organ dysfunction, such as acute kidney injury with increase in creatinine or acute lung injury with alteration in PaO<sub>2</sub>:FiO<sub>2</sub> ratio.

### Proposed Metrics To Be Added to the TRACS Database

In order to monitor preservation of vital organ function at the least physiologic cost, with the least number of complications, we propose collection of the following clinical parameters:

1. *Patient demographics:* Age, sex, admission weight, presence of comorbidities.
2. *Injury characteristics:* %TBSA burn, %full-thickness or %grafted, time of injury, time of admission, presence of inhalation injury or need for intubation, concomitant trauma.
3. *Resuscitation characteristics:* Lab values (base deficit, lactate, hemoglobin/hematocrit, blood urea nitrogen, and creatinine), intake and output values (prehospital and total fluid volumes, use of

adjunct fluids and volume—including high-dose vitamin C, hypertonic saline, fresh frozen plasma and albumin, urine output, input/output ratio, and bladder pressures), and treatments (use of vasopressors, initiation of tube feeds, use of renal replacement therapy or plasma exchange, need for decompressive procedure—escharotomy, fasciotomy, canthotomy, or laparotomy, and time to first operation).

4. *Timing and frequency of variable collection:* Intervals for the collection of clinical data will be every 6 hours for the first 24 hours of resuscitation postinjury (6, 12, 18, and 24 hours), then every 12 hours up to the 72-hour mark (36, 48, 60, and 72 hours).

### Opportunities for Research Because of Lack of Level 1 Evidence

1. Optimal timing, use, and efficacy of adjuncts to resuscitation: high-dose vitamin C, hypertonic saline, fresh frozen plasma, and albumin.
2. Role for high-volume hemofiltration, plasma exchange, and renal replacement therapy in the patient with acute kidney injury.
3. Effect of inhalation injury, intubation and mechanical ventilation, opioids and sedation, and obesity on fluid requirements and contribution to “fluid creep.”

## PRESERVATION OF LIFE AND QUALITY OF LIFE

### How It Meets Clinical Care Quality Outcomes

Compassionate care is a priority in burn centers and preservation of “meaningful life” as valued by the patient and family, could be considered as that which is an acceptable “quality of life.” The easiest marker of outcome in this domain is mortality, which can be measured by using crude mortality rates or a standard observed/expected ratio. Crude mortality has been reported for years, but lacks an ability to adjust for differences in severity of illness and coexisting medical or psychosocial comorbidities. A standardized mortality ratio, defined as the ratio of observed mortality rate to expected mortality rate, allows for risk adjustments that are performance-based comparisons by adjusting for disease category and severity of derangement. Stratification of the data can then be used to develop an applicable scoring system. The scoring system would then be used to determine whether the outcome of mortality is within an expected rate or whether there is an opportunity for improvement.

## Proposed Metrics To Be Added to the TRACS Database

Generation of and contribution to a well-populated and accurate National Burn Repository (NBR) will help in stratification of data to develop an applicable scoring system and determine how individual mortalities or burn centers compare with an expected rate. The outcome measures are:

1. Mortality (yes or no)
2. Withdrawal of support (yes or no)
3. Discharge location

## Opportunities for Research Because of Lack of Level 1 Evidence

1. Determination of an accurate expected mortality prediction for an individual patient, or validation of the existing revised Baux score through use of the NBR, to allow for creation of standardized mortality ratios.
2. Survey of major burn survivors regarding qualities that are perceived to be important for “meaningful quality of life.”

## REFERENCES

1. Greenhalgh DG. Burn resuscitation: the results of the ISBI/ABA survey. *Burns* 2010;36:176–82.
2. Engrav LH, Colescott PL, Kemalyan N, et al. A biopsy of the use of the Baxter formula to resuscitate burns or do we do it like Charlie did it? *J Burn Care Rehabil* 2000;21:91–5.
3. Cartotto RC, Innes M, Musgrave MA, Gomez M, Cooper AB. How well does the Parkland formula estimate actual fluid resuscitation volumes? *J Burn Care Rehabil* 2002;23:258–65.
4. Chung KK, Wolf SE, Cancio LC, et al. Resuscitation of severely burned military casualties: fluid begets more fluid. *J Trauma* 2009;67:231–7; discussion 237.
5. Lawrence A, Faraklas I, Watkins H, et al. Colloid administration normalizes resuscitation ratio and ameliorates “fluid creep”. *J Burn Care Res* 2010;31:40–7.
6. Cochran A, Morris SE, Edelman LS, Saffle JR. Burn patient characteristics and outcomes following resuscitation with albumin. *Burns* 2007;33:25–30.
7. Belba MK, Petrela EY, Belba GP. Comparison of hypertonic vs isotonic fluids during resuscitation of severely burned patients. *Am J Emerg Med* 2009;27:1091–6.
8. Tanaka H, Matsuda T, Miyagantani Y, Yukioka T, Matsuda H, Shimazaki S. Reduction of resuscitation fluid volumes in severely burned patients using ascorbic acid administration: a randomized, prospective study. *Arch Surg* 2000;135:326–31.
9. Ennis JL, Chung KK, Renz EM, et al. Joint Theater Trauma System implementation of burn resuscitation guidelines improves outcomes in severely burned military casualties. *J Trauma* 2008;64 (2 Suppl):S146–51; discussion S151–2.
10. Chung KK, Lundy JB, Matson JR, et al. Continuous venovenous hemofiltration in severely burned patients with acute kidney injury: a cohort study. *Crit Care* 2009;13:R62.
11. Klein MB, Edwards JA, Kramer CB, Nester T, Heimbach DM, Gibran NS. The beneficial effects of plasma exchange after severe burn injury. *J Burn Care Res* 2009;30:243–8.
12. Faraklas I, Cochran A, Saffle J. Review of a fluid resuscitation protocol: “fluid creep” is not due to nursing error. *J Burn Care Res* 2012;33:74–3.
13. Salinas J, Chung KK, Mann EA, et al. Computerized decision support system improves fluid resuscitation following severe burns: an original study. *Crit Care Med* 2011;39:2031–8.

## Nutrition Outcomes

Maggie Dylewski, PhD, RD,\* Lucy Wibbenmeyer, MD,†  
Palmer Q. Bessey, MD, FACS,‡ Jennifer Carter, RD,§  
Richard Gamelli, MD, FACS,|| Cleon Goodwin, MD, FACS,¶  
Tamara Graves, RN, BSN,# Kathleen Hollowed, RN,\*\*  
James H. Holmes IV, MD, FACS,†† John Noordenbas, RN,‡‡§§  
Megan Nordlund, MS, RD, Alisa Savetamal, MD,|||| Peggie Simpson, RN,¶¶  
Daniel Traber, PhD,## Lillian Traber, RN##

From the \*Shriners Hospitals for Children, Boston; †University of Iowa Hospitals; ‡Weill Cornell Medical College/NY Presbyterian Hospital; §The Burn Center at Washington Hospital Center, District of Columbia; ||Stritch School of Medicine, Loyola University Chicago; ¶Northern Colorado Medical Center, Greeley; #Arkansas Children's Hospital, Little Rock; \*\*The Burn Center at Washington Hospital Center, District of Columbia; ††Wake Forest University Baptist Medical Center, Winston-Salem, North

Carolina; ‡‡University of California San Diego Regional Burn Center; §§Harborview Medical Center, Seattle, Washington; ||||Bridgeport Hospital, Connecticut; ¶¶Firefighters Regional Burn Center, Memphis, Tennessee; and ## University of Texas Medical Branch, Galveston.  
Address correspondence to Maggie Dylewski, PhD, RD, Shriners Hospitals for Children, 51 Blossom Street, Boston, Massachusetts 02114.



The response to injury after a burn increases normal metabolism to such a profound degree that without caloric intervention severely injured burn patients would universally succumb to their injuries from protein-calorie malnutrition.<sup>1-5</sup> Postburn hypermetabolism is associated with profound proteolysis resulting in lean body mass loss and muscle wasting. Appropriate monitoring for nutritional needs and deficiencies and provision of adequate calories, nitrogen, micronutrients, and supplements is critical to the success of burn care. Modulation of the stress response has been attempted both with nonpharmacologic and pharmacologic means.<sup>6-12</sup> Nonpharmacologic means include: early operative intervention, thermoregulation of environment, and enteral nutrition. Pharmacologic interventions have included intensive insulin control,  $\beta$ -blockade (BB), and anabolic agents. The goal of the Quality Consensus Conference was to develop metrics that may be added to the American Burn Association (TRACS) Burn Registry database for the purpose of tracking burn outcome measures. The following summary outlines metrics proposed by the Nutrition Consensus Work Group:

1. Total calorie and protein intake during the first week of admission
2. Weight loss throughout the acute phase of injury (admit weight [or dry weight] – discharge weight)
3. Use of glutamine (yes or no)
4. Weekly average blood glucose levels
5. Average weekly heart rate
6. Use of oxandrolone (yes or no). These metrics are based on available evidence, although numerous gaps were identified in the evidence. Therefore, areas of research needs are also presented in this report.

## PROVISION OF ENERGY AND PROTEIN

### How It Meets Clinical Care Quality Outcomes

The delivery of adequate calories and protein is a priority in the burn unit, as it reduces morbidity and mortality associated with critical illness. Cumulative energy deficits during the first week of admission correlate with numerous complications including infection, sepsis, and pressure sores.<sup>13-15</sup> Correspondingly, substantial loss of lean body mass impairs wound healing.<sup>16</sup> Therefore, monitoring calorie and protein intake is essential.

Available tools for monitoring nutritional status after a burn injury are not consistently used among

the burn community. Trending visceral protein measurements with acute-phase reactants is a common practice among burn units; however, supporting evidence is lacking. Two studies, including 121 burn patients<sup>17,18</sup> suggest that C-reactive protein/prealbumin (transferrin) predicts morbidity and mortality. In contrast, two smaller studies<sup>19,20</sup> suggest that these biomarkers are unreliable. Because of the lack of evidence and consensus, no recommendation on tracking visceral proteins can be made at this time.

### Proposed Metrics To Be Added to the TRACS Database

Because of the fact that adequate provision of nutrition is essential for positive outcomes, energy and protein intake should be monitored closely.

The proposed measureable outcomes are:

1. Total calorie and protein intake during the first week of admission
2. Weight loss throughout the acute phase of injury (admit weight [dry weight] and discharge weight)

### Opportunities for Research Because of Lack of Level 1 Evidence

1. Multicenter trials to develop equations that accurately estimate energy needs for all populations of burn patients (adult, pediatric, and obese patients)
2. Contemporary studies to assess the protein needs of pediatric and adult burn patients
3. Multicenter studies to assess the reliability of visceral proteins for assessing nutritional status and predicting outcomes

## NUTRITIONAL ADJUNCTS

### How It Meets Clinical Care Quality Outcomes

Specific nutrient supplementation, in addition to standard nutrition support, is often administered to burn patients. Studies report several advantages to glutamine; however, information on the benefits of other nutrients is lacking. Glutamine has several valuable functions that may be beneficial to burn patients. Evidence among adult burn patients shows that enteral glutamine supplementation decreases infection rates,<sup>21,22</sup> mortality,<sup>21</sup> length of stay (LOS),<sup>22,23</sup> and preserves gut integrity.<sup>22,23</sup> Of note, these studies include small sample sizes ( $n = 40-48$ ) and diverse dosing methods. Nevertheless, it is reasonable to conclude from this data that adult burn



patients benefit from glutamine. However, supporting evidence among pediatric burn patients is scarce. The only study addressing this population, published in 2004 by Sheridan et al,<sup>24</sup> found no benefits to glutamine supplementation. Although other single nutrients or nutrient combinations are commonly supplemented in burn patients, no concrete evidence is available to support this practice. Studies do report depressed levels of vitamin C,<sup>24</sup> vitamin D,<sup>25</sup> selenium,<sup>26,27</sup> vitamin E,<sup>24,28</sup> zinc, and copper<sup>26,29–32</sup> among burn patients. However, supplementation studies are scarce and do not provide definitive guidance for appropriate micronutrient provision. Because of lack of research, no recommendation on micronutrient supplementation or tracking micronutrient status can be made at this time.

### Proposed Metrics To Be Added to the TRACS Database

Data indicate that glutamine is beneficial to adult burn patients. Glutamine's use should be monitored closely.

The proposed outcome measure is:

Use of glutamine (yes or no)

### Opportunities for Research Because of Lack of Level 1 Evidence

Multicenter trials are needed to assess the benefits of glutamine for pediatric burn patients and to determine specific micronutrient benefits for pediatric and adult burn patients.

## CONTROL OF STRESS-INDUCED HYPERGLYCEMIA

### How It Meets Clinical Care Quality Outcomes

Hyperglycemia has been associated with several adverse effects in burn patient populations. These include: stimulation of a persistent inflammatory state; poor wound healing, protein catabolism, infection, and death.<sup>33–43</sup> Correction of hyperglycemia may ameliorate these adverse effects, affecting patient LOS, discharge disposition (home vs nursing home or rehabilitation center) and reintegration into society.

### Proposed Metrics To Be Added to the TRACS Database

Data indicate that hyperglycemia control is beneficial for pediatric and adult burn patients.

The proposed outcome measure is:

Weekly average blood glucose levels

### Opportunities for Research Because of Lack of Level 1 Evidence

1. Multicenter trials to address the impact of the treatment of stress-induced hyperglycemia on the standard clinical outcomes of LOS, wound healing, infection, and mortality.
2. Multicenter trials should specify the use of multichannel glucometers, as single-channel glucometers are prone to significant error in anemic patients.<sup>44</sup>

## BETA-BLOCKADE

### How It Meets Clinical Care Quality Outcomes

Catecholamines are the main drivers of the hypermetabolic response to burn injury,<sup>45</sup> with levels rising nearly 10-fold after injury.<sup>45,46</sup> Catecholamines increase cardiac work, drive lipolysis, enhance glycogenolysis, and impair glucose disposal by altering insulin signaling.<sup>47</sup> Blocking the catecholamine surge could potentially improve multiple aspects of the postburn hypermetabolism. Known benefits of  $\beta$  blockers include suppression of lipolysis, decreased resting energy expenditure, preservation of lean body mass, and decreased LOS.<sup>48–53</sup>

### Proposed Metrics To Be Added to the TRACS Database

Data indicate that BB is beneficial to pediatric and adult burn patients. BB use should be monitored closely.

The proposed outcome measures are:

1. Average weekly heart rate
2. Weight loss (admit weight [dry weight] and discharge weight)

### Opportunities for Research Because of Lack of Level 1 Evidence

A multicenter prospective, randomized, double-blind, controlled study should address the pediatric and adult populations that benefit from BB tracking clinical outcomes and the safety of  $\beta$ -blocker use.

## OXANDROLONE

### How It Meets Clinical Care Quality Outcomes

Hypermetabolism leads to protein-calorie malnutrition, muscle wasting, deconditioning, and delayed wound healing. These factors can prolong LOS and hospital costs. Modulation of the postburn hypermetabolism with oxandrolone supplementation can potentially ameliorate these consequences.<sup>53–61</sup>

## Proposed Metrics To Be Added to the TRACS Database

Data indicate that oxandrolone is beneficial to pediatric and adult burn patients. Oxandrolone use should be monitored closely.

The proposed outcome measures are:

1. Use of oxandrolone (yes or no)
2. Weight loss (admit weight [dry weight] and discharge weight)

## Opportunities for Research Because of Lack of Level 1 Evidence

A multicenter prospective, randomized, double-blind controlled study of pediatric and adult burn patients with burn sizes >20% should address which patients benefit from oxandrolone, the safety of its use, and appropriate clinical outcome measures (LOS and maintenance of body weight).

## REFERENCES

1. Hart DW, Wolf SE, Chinkes DL, et al. Determinants of skeletal muscle catabolism after severe burn. *Ann Surg* 2000;232:455–65.
2. Jeschke MG, Norbury WB, Finnerty CC, Branski LK, Herndon DN. Propranolol does not increase inflammation, sepsis, or infectious episodes in severely burned children. *J Trauma* 2007;62:676–81.
3. Kelemen JJ 3rd, Cioffi WG Jr, Mason AD Jr, Mazingo DW, McManus WF, Pruitt BA Jr. Effect of ambient temperature on metabolic rate after thermal injury. *Ann Surg* 1996;223:406–12.
4. Matsuda T, Clark N, Hariyani GD, Bryant RS, Hanumadass ML, Kagan RJ. The effect of burn wound size on resting energy expenditure. *J Trauma* 1987;27:115–8.
5. Mlcak RP, Jeschke MG, Barrow RE, Herndon DN. The influence of age and gender on resting energy expenditure in severely burned children. *Ann Surg* 2006;244:121–30.
6. Atiyeh BS, Gunn SW, Dibo SA. Nutritional and pharmacological modulation of the metabolic response of severely burned patients: review of the literature (part II)\*. *Ann Burns Fire Disasters* 2008;21:119–23.
7. Hart DW, Wolf SE, Chinkes DL, et al. Effects of early excision and aggressive enteral feeding on hypermetabolism, catabolism, and sepsis after severe burn. *J Trauma* 2003;54:755–61; discussion 761–4.
8. Jeschke MG, Mlcak RP, Finnerty CC, et al. Burn size determines the inflammatory and hypermetabolic response. *Crit Care* 2007;11:R90.
9. Noordenbos J, Hansbrough JF, Gutmacher H, Doré C, Hansbrough WB. Enteral nutritional support and wound excision and closure do not prevent postburn hypermetabolism as measured by continuous metabolic monitoring. *J Trauma* 2000;49:667–71; discussion 671–2.
10. Peck MD, Kessler M, Cairns BA, Chang YH, Ivanova A, Schooler W. Early enteral nutrition does not decrease hypermetabolism associated with burn injury. *J Trauma* 2004;57:1143–8; discussion 1148–9.
11. Wasiak J, Cleland H, Jeffery R. Early versus late enteral nutritional support in adults with burn injury: a systematic review. *J Hum Nutr Diet* 2007;20:75–3.
12. Wilmore DW, Mason AD Jr, Johnson DW, Pruitt BA Jr. Effect of ambient temperature on heat production and heat loss in burn patients. *J Appl Physiol* 1975;38:593–7.
13. Dvir D, Cohen J, Singer P. Computerized energy balance and complications in critically ill patients: an observational study. *Clin Nutr* 2006;25:37–4.
14. Faisy C, Candela Llerena M, Savalle M, Mainardi JL, Fagon JY. Early ICU energy deficit is a risk factor for *Staphylococcus aureus* ventilator-associated pneumonia. *Chest* 2011;140:1254–60.
15. Villet S, Chiolerio RL, Bollmann MD, et al. Negative impact of hypocaloric feeding and energy balance on clinical outcome in ICU patients. *Clin Nutr* 2005;24:502–9.
16. Moran L, Custer P, Murphy G. Nutritional assessment of lean body mass. *J Parenter Enteral Nutr* 1980; 4:595.
17. Cynober L, Prugnaud O, Lioret N, Duchemin C, Saizy R, Giboudeau J. Serum transthyretin levels in patients with burn injury. *Surgery* 1991;109:640–4.
18. Gottschlich MM, Baumer T, Jenkins M, Khoury J, Warden GD. The prognostic value of nutritional and inflammatory indices in patients with burns. *J Burn Care Rehabil* 1992;13:105–13.
19. Carlson DE, Cioffi WG Jr, Mason AD Jr, McManus WF, Pruitt BA Jr. Evaluation of serum visceral protein levels as indicators of nitrogen balance in thermally injured patients. *J Parenter Enteral Nutr* 1991;15:440–4.
20. Rettmer RL, Williamson JC, Labbé RF, Heimbach DM. Laboratory monitoring of nutritional status in burn patients. *Clin Chem* 1992;38:334–7.
21. Garrel D, Patenaude J, Nedelec B, et al. Decreased mortality and infectious morbidity in adult burn patients given enteral glutamine supplements: a prospective, controlled, randomized clinical trial. *Crit Care Med* 2003;31:2444–9.
22. Zhou YP, Jiang ZM, Sun YH, Wang XR, Ma EL, Wilmore D. The effect of supplemental enteral glutamine on plasma levels, gut function, and outcome in severe burns: a randomized, double-blind, controlled clinical trial. *J Parenter Enteral Nutr* 2003; 27:241–5.
23. Peng X, Yan H, You Z, Wang P, Wang S. Effects of enteral supplementation with glutamine granules on intestinal mucosal barrier function in severe burned patients. *Burns* 2004;30:135–9.
24. Sheridan RL, Prelack K, Yu YM, et al. Short-term enteral glutamine does not enhance protein accretion in burned children: a stable isotope study. *Surgery* 2004;135:671–8.
25. Rock CL, Dechert RE, Khilnani R, Parker RS, Rodriguez JL. Carotenoids and antioxidant vitamins in patients after burn injury. *J Burn Care Rehabil* 1997;18:269–78; discussion 268.
26. Gottschlich MM, Mayes T, Khoury J, Warden GD. Hypovitaminosis D in acutely injured pediatric burn patients. *J Am Diet Assoc* 2004;104:931–41, quiz 1031.
27. Berger MM, Cavadini C, Bart A, et al. Cutaneous copper and zinc losses in burns. *Burns* 1992;18:373–80.
28. Dylewski ML, Bender JC, Smith AM, et al. The selenium status of pediatric patients with burn injuries. *J Trauma* 2010;69:584–8; discussion 588.
29. Traber MG, Leonard SW, Traber DL, et al. alpha-Tocopherol adipose tissue stores are depleted after burn injury in pediatric patients. *Am J Clin Nutr* 2010; 92:1378–84.
30. Cunningham J, Leffell M, Harmatz P. Burn severity, copper dose, and plasma ceruloplasmin in burned children during total parenteral nutrition. *Nutrition* 1993; 9:329–2.
31. Gosling P, Rothe HM, Sheehan TM, Hubbard LD. Serum copper and zinc concentrations in patients with burns in relation to burn surface area. *J Burn Care Rehabil* 1995;16:481–6.
32. Khorasani G, Hosseinimehr SJ, Kaghazi Z. The alteration of plasma's zinc and copper levels in patients with burn injuries and the relationship to the time after burn injuries. *Singapore Med J* 2008;49:627–30.

33. Voruganti VS, Klein GL, Lu HX, Thomas S, Freeland-Graves JH, Herndon DN. Impaired zinc and copper status in children with burn injuries: need to reassess nutritional requirements. *Burns* 2005;31:711–6.
34. Gore DC, Chinkes D, Heggers J, Herndon DN, Wolf SE, Desai M. Association of hyperglycemia with increased mortality after severe burn injury. *J Trauma* 2001;51:540–4.
35. Mizock BA. Alterations in fuel metabolism in critical illness: hyperglycaemia. *Best Pract Res Clin Endocrinol Metab* 2001;15:533–51.
36. Ferrando AA, Chinkes DL, Wolf SE, Matin S, Herndon DN, Wolfe RR. A submaximal dose of insulin promotes net skeletal muscle protein synthesis in patients with severe burns. *Ann Surg* 1999;229:11–8.
37. Gibson BR, Galiatsatos P, Rabiee A, et al. Intensive insulin therapy confers a similar survival benefit in the burn intensive care unit to the surgical intensive care unit. *Surgery* 2009;146:922–30.
38. Gore DC, Chinkes DL, Hart DW, Wolf SE, Herndon DN, Sanford AP. Hyperglycemia exacerbates muscle protein catabolism in burn-injured patients. *Crit Care Med* 2002;30:2438–42.
39. Hemmila MR, Taddonio MA, Arbabi S, Maggio PM, Wahl WL. Intensive insulin therapy is associated with reduced infectious complications in burn patients. *Surgery* 2008;144:629–35; discussion 635–7.
40. Jeschke MG, Kraft R, Emdad F, Kulp GA, Williams FN, Herndon DN. Glucose control in severely thermally injured pediatric patients: what glucose range should be the target? *Ann Surg* 2010;252:521–7; discussion 527–8.
41. Pham TN, Warren AJ, Phan HH, Molitor F, Greenhalgh DG, Palmieri TL. Impact of tight glycemic control in severely burned children. *J Trauma* 2005;59:1148–54.
42. Pierre EJ, Barrow RE, Hawkins HK, et al. Effects of insulin on wound healing. *J Trauma* 1998;44:342–5.
43. Thomas SJ, Morimoto K, Herndon DN, et al. The effect of prolonged euglycemic hyperinsulinemia on lean body mass after severe burn. *Surgery* 2002;132:341–7.
44. Tuvdendorj D, Zhang XJ, Chinkes DL, et al. Intensive insulin treatment increases donor site wound protein synthesis in burn patients. *Surgery* 2011;149:512–8.
45. Mann EA, Mora AG, Pidcoke HF, Wolf SE, Wade CE. Glycemic control in the burn intensive care unit: focus on the role of anemia in glucose measurement. *J Diabetes Sci Technol* 2009;3:1319–29.
46. Wilmore DW, Long JM, Mason AD Jr, Skreen RW, Pruitt BA Jr. Catecholamines: mediator of the 270 hypermetabolic response to thermal injury. *Ann Surg* 1974;180:653–9.
47. Goodall M, Stone C, Haynes BW Jr. Urinary output of adrenaline and noradrenaline in severe 272 thermal burns. *Ann Surg* 1957;145:479–87.
48. Robinson LE, van Soeren MH. Insulin resistance and hyperglycemia in critical illness: role of insulin in glycemic control. *AACN Clin Issues* 2004;15:45–2.
49. Wolfe RR, Herndon DN, Peters EJ, Jahoor F, Desai MH, Holland OB. Regulation of lipolysis in severely burned children. *Ann Surg* 1987;206:214–21.
50. Arbabi S, Ahrns KS, Wahl WL, et al. Beta-blocker use is associated with improved outcomes in adult burn patients. *J Trauma* 2004;56:265–69; discussion 269–271.
51. Herndon DN, Barrow RE, Rutan TC, Minifee P, Jahoor F, Wolfe RR. Effect of propranolol administration on hemodynamic and metabolic responses of burned pediatric patients. *Ann Surg* 1988;208:484–92.
52. Herndon DN, Hart DW, Wolf SE, Chinkes DL, Wolfe RR. Reversal of catabolism by beta-blockade 283 after severe burns. *N Engl J Med* 2001;345:1223–29.
53. Herndon DN, Nguyen TT, Wolfe RR, et al. Lipolysis in burned patients is stimulated by the beta 2-receptor for catecholamines. *Arch Surg* 1994;129:1301–4; discussion 1304–5.
54. Jeschke MG, Finnerty CC, Suman OE, Kulp G, Mlcak RP, Herndon DN. The effect of oxandrolone 287 on the endocrinologic, inflammatory, and hypermetabolic responses during the acute phase postburn. *Ann Surg* 2007;246:351–60; discussion 360–352.
55. Barrow RE, Dasu MR, Ferrando AA, et al. Gene expression patterns in skeletal muscle of thermally injured children treated with oxandrolone. *Ann Surg* 2003;237:422–8.
56. Demling RH. Comparison of the anabolic effects and complications of human growth hormone and the testosterone analog, oxandrolone, after severe burn injury. *Burns* 1999;25:215–21.
57. Demling RH, Orgill DP. The anticatabolic and wound healing effects of the testosterone analog oxandrolone after severe burn injury. *J Crit Care* 2000;15:12–7.
58. Hart DW, Wolf SE, Ramzy PI, et al. Anabolic effects of oxandrolone after severe burn. *Ann Surg* 2001;233:556–64.
59. Wolf SE, Edelman LS, Kemalyan N, et al. Effects of oxandrolone on outcome measures in the severely burned: a multicenter prospective randomized double-blind trial. *J Burn Care Res* 2006;27:131–9; discussion 140–1.
60. Wolf SE, Thomas SJ, Dasu MR, et al. Improved net protein balance, lean mass, and gene expression changes with oxandrolone treatment in the severely burned. *Ann Surg* 2003;237:801–10; discussion 810–1.

# Functional Outcomes

Bernadette Nedelec, PhD, BSc OT,\* Matthias Donelan, MD, FACS,†  
 Mary Jo Baryza, PT, MS, PCS,† Dhaval Bhavsar, MD,‡  
 Sigrid Blome-Eberwein, MD,§ Gretchen J. Carrougher, RN, MN,||  
 William Hickerson, MD, FACS,¶ Victor Joe, MD,# Marion Jordan, MD, FACS,\*\*  
 Karen Kowalske, MD,†† Derek Murray, MSPT, BSBA,‡‡  
 Vimal K. Murray, MD, FACS,§§ Ingrid Parry, MS, PT,||||  
 Michael Peck, MD, ScD, FACS,‡‡ Debra Reilly, MD,¶¶ Jeffrey C. Schneider, MD,##  
 Linda Ware, OT, CHT\*\*\*

Almost all burn survivors who require admission to a verified burn center will have functional deficits, at least temporarily. Although the overall incidence of major burn injuries has declined, patients who do sustain severe burn injuries are more likely to survive<sup>1,2</sup> because of advancements in critical care and surgical management. Thus,<sup>3</sup> patients who survive are likely to have complex and burn-specific rehabilitation needs to reduce the risk of chronic disability. The evaluation of the functional outcomes of burn survivors is an equally complex challenge. The World Health Organization developed the International Classification of Functioning, Disability and Health,<sup>4</sup> which divides the assessment of health outcomes into body functions and structure, activity, and participation. The deficits identified during the assessment process are subsequently referred to as impairments (body functions and structure limitations), activity limitations, and participation restrictions. This classification is useful for the conceptualization and organization of the outcome measures and findings that are commonly associated with burn injuries. One of the most obvious body structures affected by a burn injury is

skin. After wound healing, skin-associated impairments that have been identified include the formation of hypertrophic scar,<sup>5-7</sup> pruritus,<sup>7-16</sup> impaired sensation,<sup>7,13,17-22</sup> edema,<sup>23,24</sup> thermoregulation,<sup>25</sup> and pain.<sup>7,13,26,27</sup> Additional body functions and structure-level impairments include decreased joint range of motion,<sup>28-31</sup> decreased muscle strength,<sup>32-39</sup> impaired balance,<sup>31</sup> and reduced cardiovascular endurance<sup>33-38,40</sup> as well as cognitive deficits, particularly related to electrical injuries.<sup>41-45</sup> Activity limitations that have been described in burn survivors include a broad spectrum of activities including hand function,<sup>31,46-51</sup> mobility,<sup>39,52,53</sup> activities of daily living,<sup>39,52,54,55</sup> and sexuality.<sup>56,57</sup> Participation restrictions have been examined as they apply to return to work (RTW)<sup>58</sup> or school<sup>59-62</sup> and community reintegration.<sup>55,63</sup> Evaluation of overall quality of life is a complex construct that includes variables representing all three domains of the International Classification of Functioning, Disability and Health including impairments, activity limitations, and participation restrictions. Quality of life in burn survivors has been evaluated using a number of different quality-of-life measures, which evaluated the predictive impact of a number of potentially related variables.<sup>39,51,53,54,64-82</sup> Perusal of the literature demonstrates that the list of measures used to capture functional outcomes in the burn survivor population is extensive and diverse. Each measure was reviewed as a potential metric for prospective and ongoing inclusion in the American Burn Association TRACS/National Burn Registry. The following summary outlines the metrics proposed by the Functional Outcomes working group:

1. Documentation of injury using photography
2. Patient assessment by occupational or physical therapy
3. Self-report of health-related quality of life
4. Employment and/or school status postburn

*From the \*School of Physical and Occupational Therapy, Centre hospitalier de l'Université de Montréal, McGill University, Montreal, Quebec, Canada; †Shriners Hospital for Children, Boston; ‡University of Kansas Medical Center, Kansas City; §Lehigh Valley Health Network, Allentown, Pennsylvania; ||Harborview Medical Center, Seattle, Washington; ¶Firefighters Regional Burn Center, Memphis, Tennessee; #Arrowhead Regional Medical Center, Colton, California; \*\*Burn Center at Washington Hospital, District of Columbia; ††UT Southwestern Medical Center, Dallas, Texas; ‡‡Arizona Burn Center, Phoenix, Arizona; §§Torrance Memorial Burn/Wound Center, Torrance, California; ||||Shriners Hospital for Children, Sacramento, California; ¶¶Nebraska Medical Center, Omaha; ##Spaulding Rehabilitation Hospital, Boston; and \*\*\*Johns Hopkins Bayview Medical Center, Baltimore, Maryland.*

*Address correspondence to Bernadette Nedelec, PhD, BSc OT, McGill University, School of Physical and Occupational Therapy, Centre de recherche, Centre hospitalier de l'Université de Montréal, 3654 Promenade Sire William Osler, Montreal, Quebec, H3G 1Y5, Canada.*



## PHOTOGRAPHIC DOCUMENTATION OF INJURY

### How It Meets Clinical Care Quality Outcomes

Documentation of injury using photography is a process indicator that is believed to be a necessary standard, indicative of quality healthcare.

### Proposed Metrics for the TRACS Database

1. Were photographs taken at admission and stored in the medical record? (yes/no)
2. Were photographs taken at wound closure or discharge from acute care and stored in the medical record? (yes/no)
3. Were photographs taken at 1 month, 6 months, and 12 months after burn injury and stored in the medical record? (yes/no for each time point)

## OCCUPATIONAL AND/OR PHYSICAL THERAPY ASSESSMENT

### How It Meets Clinical Care Quality Outcomes

Despite a lack of research identifying best practices in burn rehabilitation, the Functional Outcomes working group supports the clinical competencies recently published for burn rehabilitation therapists.<sup>83</sup> Specifically, the panel believes that a key indicator of quality patient care after an acute burn injury requiring hospitalization is a comprehensive rehabilitation evaluation (competency 1.1.4)<sup>83</sup> within 48 hours of admission to a burn center.

### Proposed Metrics for the TRACS Database

Did an occupational or physical therapist assess the patient within 48 hours of admission? (yes/no)

## HEALTH-RELATED QUALITY-OF-LIFE ASSESSMENT

### How It Meets Clinical Care Quality Outcomes

The ideal goal after treatment for a burn injury, as stated by the British Burns Association, is “to recover the individual to the preinjury state and for them to return to their place in society with unaltered potential” (<sup>84</sup> p. 16). The Consensus Panel agreed that our ultimate clinical goal is to achieve functional outcomes that patients are satisfied with, whether or not a residual impairment persists. They also agreed that the following guiding principles would be used for metric selection: 1) limit proposed data collection to a realistic target, 2) ensure that the measure can be administered

in a consistent, standard manner across time and different locations, 3) ensure that the burn survivor can be followed up after discharge from the acute care burn center and that the measure can be administered by telephone, and 4) ensure that the measurement has specifically been developed to evaluate burn survivors so that important injury-specific information is captured. We concluded that because self-reported quality of life is the ultimate goal of rehabilitation programs, health-related quality-of-life (HRQoL) measures should be prioritized in the development of functional outcome metrics within TRACS. This conclusion does not reduce the need to better understand the relationship between HRQoL and burn-related impairments and activity limitations, but these relationships could more accurately and feasibly be examined on a smaller scale by centers that are appropriately funded and resourced to do so.

### Proposed Metrics for the TRACS Database

One of the following questionnaires should be completed at hospital discharge, 1 month, 6 months, and 12 months postburn, depending on the age of the patient/burn survivor at the time of the assessment:

- a. Burn Specific Health Scale-Brief (BSHS-B) (adults)
- b. Health Outcomes Burn Questionnaires (children aged 0 to 5 years and children aged 6 to 17 years)

The BSHS-B for individuals aged 18 years and older, contains 40 self-report statements; burn survivors provide their perceived difficulties on a 0 to 4 scale where 0 indicates “extreme” difficulty and 4 is defined as “not at all” difficult. Each item is divided into nine subscales: heat sensitivity, affect, hand function, treatment regimens, work, sexuality, interpersonal relationships, simple abilities, and body image.<sup>85</sup> The BSHS-B has been shown to have adequate reliability and validity by establishing its association with injury severity, long-term use of care facilities, sociodemographic variables, personality traits, coping strategies, dysfunctional beliefs, and HRQoL.<sup>86</sup>

For the pediatric population, two questionnaires exist. For children aged 0 to 5 years, the Children Burn Outcomes Questionnaire for infants and children is recommended.<sup>87</sup> The parent or guardian should complete this questionnaire. The measure consists of 55 items and 10 domains (play, language, fine motor, gross motor behavior, family, pain/itching, appearance, satisfaction, concern/worry) that are evaluated on a 0 to 4 scale.



For children aged 6 to 17 years, the Children Burn Outcomes Questionnaire is recommended.<sup>88</sup> Parents or guardians complete the questionnaire for children younger than 11 years, and children aged 11 to 17 years old complete the questionnaire as a self-report measure. This questionnaire consists of 52 items and 12 domains (upper extremity function, physical function and sports, transfers and mobility, pain, itch, appearance, compliance, satisfaction with current state, emotional health, family disruption, parental concern, and school reentry). Using these outcome measures, extensive data has been collected and analyzed as part of the Multi-Center Benchmarking Study.<sup>89</sup> As a result, recovery curves have been developed to allow comparisons with the questionnaires outcome domains.

## EMPLOYMENT AND SCHOOL REENTRY

### How It Meets Clinical Care Quality Outcomes

A single outcome variable indicative of successful reintegration, functional abilities, and social rehabilitation after injury is RTW<sup>58,90</sup> and school.<sup>59-61</sup> In the adult population, despite both physical and psychosocial barriers to RTW, many burn survivors do RTW within several months of injury,<sup>91</sup> yet as many as 28% never return to any form of employment.<sup>58</sup> In the pediatric population, return to school is relatively short.<sup>59-61</sup> Consequently, documentation of this variable is an important tool to assist with monitoring the efficacy of burn care.

### Proposed Metrics for the TRACS Database

1. Date that the patient returned to work or school (days to RTW /school can then be calculated from date of injury)
2. How many hours per week does the patient go to work for pay or to school? \_\_\_\_\_
- 3) Compared with before the burn injury is the patient currently with:
  - i. same job, same employer
  - ii. different job, same employer
  - iii. same job, different employer
  - iv. different job, different employer, or
  - v. was not working before burn injury?

## GAPS IN KNOWLEDGE AND OPPORTUNITIES FOR RESEARCH

One of the most important measurement challenges in understanding functional outcomes after burn injury is targeting appropriate constructs of interest

without creating excessive respondent burden or a data set that becomes unwieldy and nonfeasible over the long term or across multiple centers. There are also inherent challenges to measuring functional outcomes across the life span, of diverse populations, with hugely variant premorbid health and individual functional outcome expectations, which are based on their preinjury work, leisure, domestic activities, and demands. Further research is required to better understand the relationship between HRQoL and burn-related impairments and activity limitations and to develop measures for outcomes of particular interest in burn rehabilitation.

Establishing outcome measures that can be compared across centers will help with research on comparative outcomes, and over time some standards could perhaps be used as a quality-assessment tool to facilitate additional reimbursement or as a component of the burn-verification process. The challenge of this approach is that the biggest predictor of these types of outcomes after a burn injury are premorbid psychosocial factors, which may make comparison very difficult, thus, efforts will need to be made to control for these factors where possible. These recommendations by the Functional Outcomes work group are considered a starting point in what should be an ongoing development process to gradually refine and enhance the data collection associated with this metric.

## REFERENCES

1. Saffle JR, Davis B, Williams P. Recent outcomes in the treatment of burn injury in the United States: a report from the American Burn Association Patient Registry. *J Burn Care Rehabil* 1995;16(3 Pt 1):219-32; discussion 288-9.
2. Pruitt BA, Goodwin SW, Mason AD. Epidemiological, demographic, and outcome characteristics of burn injury. In: Herndon DN, editor. *Total burn care*. 2nd ed. Toronto: Saunders; 2002.
3. Brigham PA, McLoughlin E. Burn incidence and medical care use in the United States: estimates, trends, and data sources. *J Burn Care Rehabil* 1996;17:95-7.
4. World Health Organization. International Classification of Functioning, Disability and Health. Available from: <http://www.who.int/classifications/icf/en/>.
5. Lawrence JW, Mason ST, Schomer K, Klein MB. Epidemiology and impact of scarring after burn injury: a systematic review of the literature. *J Burn Care Res* 2012;33:136-46.
6. Gangemi EN, Gregori D, Berchialla P, et al. Epidemiology and risk factors for pathologic scarring after burn wounds. *Arch Facial Plast Surg* 2008;10:93-2.
7. Holavanahalli RK, Helm PA, Kowalske KJ. Long-term outcomes in patients surviving large burns: the skin. *J Burn Care Res* 2010;31:631-9.
8. Parnell LK, Nedelec B, Rachelska G, LaSalle L. Assessment of pruritus characteristics and impact on burn survivors. *J Burn Care Res* 2012;33:407-18.
9. Parent-Vachon M, Parnell LK, Rachelska G, LaSalle L, Nedelec B. Cross-cultural adaptation and validation of the Questionnaire for Pruritus Assessment for use in

- the French Canadian burn survivor population. *Burns* 2008;34:71–2.
10. LaSalle L, Rachelska G, Nedelec B. Naltrexone for the management of post-burn pruritus: a preliminary report. *Burns* 2008;34:797–2.
11. Van Loey NE, Bremer M, Faber AW, Middelkoop E, Nieuwenhuis MK. Itching following burns: epidemiology and predictors. *Br J Dermatol* 2008;158:95–100.
12. Willebrand M, Low A, Dyster-Aas J, et al. Pruritus, personality traits and coping in long-term follow-up of burn-injured patients. *Acta Derm Venereol* 2004;84:375–80.
13. Malenfant A, Forget R, Amsel R, Papillon J, Frigon JY, Choinière M. Tactile, thermal and pain sensibility in burned patients with and without chronic pain and paresthesia problems. *Pain* 1998;77:241–51.
14. Casaer M, Kums V, Wouters PJ, Van den kerckhove E, Van den Berghe G. Pruritus in patients with small burn injuries. *Burns* 2008;34:185–91.
15. Vitale M, Fields-Blache C, Luterman A. Severe itching in the patient with burns. *J Burn Care Rehabil* 1991;12:330–3.
16. Bell L, McAdams T, Morgan R, et al. Pruritus in burns: a descriptive study. *J Burn Care Rehabil* 1988;9:305–8.
17. Nedelec B, Hou Q, Sohbi I, Choinière M, Beauregard G, Dykes RW. Sensory perception and neuroanatomical structures in normal and grafted skin of burn survivors. *Burns* 2005;31:817–30.
18. Ward RS, Saffle JR, Schnebly WA, Hayes-Lundy C, Reddy R. Sensory loss over grafted areas in patients with burns. *J Burn Care Rehabil* 1989;10:536–8.
19. Ward RS, Tuckett RP, English KB, Johansson O, Saffle JR. Substance P axons and sensory threshold increase in burn-graft human skin. *J Surg Res* 2004;118:154–60.
20. Ware JE, Snow KK, Kosinski M, Gandek B. SF-36 Health survey: manual and interpretation guide. Lincoln, RI: Quality Metric Inc.; 2000.
21. Waris T, Astrand K, Hämäläinen H, Piironen J, Valtimo J, Järvilehto T. Regeneration of cold, warmth and heat-pain sensibility in human skin grafts. *Br J Plast Surg* 1989;42:576–80.
22. Hermanson A, Jonsson CE, Lindblom U. Sensibility after burn injury. *Clin Physiol* 1986;6:507–21.
23. Demling RH. The burn edema process: current concepts. *J Burn Care Rehabil* 2005;26:207–27.
24. Edgar DW, Fish JS, Gomez M, Wood FM. Local and systemic treatments for acute edema after burn injury: a systematic review of the literature. *J Burn Care Res* 2011;32:334–47.
25. Schneider JC, Spires MC. Burn rehabilitation. In: Frontera WR, DeLisa JA, Gans BM, et al, editors. *Physical medicine and rehabilitation: principles and practice*. 5th ed. Baltimore, MD: Lippincott Williams & Wilkins; 2010.
26. Schneider JC, Harris NL, El Shami A, et al. A descriptive review of neuropathic-like pain after burn injury. *J Burn Care Res* 2006;27:524–8.
27. Malenfant A, Forget R, Papillon J, et al. Prevalence and characteristics of chronic sensory problems in burn patient. *Pain* 1996;67:493–500.
28. Schneider JC et al. Contracture in burn injury part II: investigating joints of the hand. *JBCR* 2008;29:606–13.
29. Schneider JC, Holavanahalli R, Helm P, Goldstein R, Kowalske K. Contractures in burn injury: defining the problem. *J Burn Care Res* 2006;27:508–14.
30. Leblebici B, Adam M, Bağış S, et al. Quality of life after burn injury: the impact of joint contracture. *J Burn Care Res* 2006;27:864–8.
31. Schneider JC, Qu HD, Lowry J, Walker J, Vitale E, Zona M. Efficacy of inpatient burn rehabilitation: a prospective pilot study examining range of motion, hand function and balance. *Burns* 2012;38:164–71.
32. St-Pierre DM, Choinière M, Forget R, Garrel DR. Muscle strength in individuals with healed burns. *Arch Phys Med Rehabil* 1998;79:155–61.
33. Suman OE, Thomas SJ, Wilkins JP, Mlcak RP, Herndon DN. Effect of exogenous growth hormone and exercise on lean mass and muscle function in children with burns. *J Appl Physiol* 2003;94:2273–81.
34. Suman OE, Herndon DN. Effects of cessation of a structured and supervised exercise conditioning program on lean mass and muscle strength in severely burned children. *Arch Phys Med Rehabil* 2007;88(12 Suppl 2):S24–9.
35. Przkora R, Przkora R, Herndon DN, Suman OE. The effects of oxandrolone and exercise on muscle mass and function in children with severe burns. *Pediatrics* 2007;119:e109–16.
36. Alloju SM, Herndon DN, McEntire SJ, Suman OE. Assessment of muscle function in severely burned children. *Burns* 2008;34:452–9.
37. Suman OE, Spies RJ, Celis MM, Mlcak RP, Herndon DN. Effects of a 12-wk resistance exercise program on skeletal muscle strength in children with burn injuries. *J Appl Physiol* 2001;91:1168–75.
38. Al-Mousawi AM, Williams FN, Mlcak RP, Jeschke MG, Herndon DN, Suman OE. Effects of exercise training on resting energy expenditure and lean mass during pediatric burn rehabilitation. *J Burn Care Res* 2010;31:400–8.
39. Baker CP, Russell WJ, Meyer W 3rd, Blakeney P. Physical and psychologic rehabilitation outcomes for young adults burned as children. *Arch Phys Med Rehabil* 2007;88(12 Suppl 2):S57–64.
40. de Lateur BJ, Magyar-Russell G, Bresnick MG, et al. Augmented exercise in the treatment of deconditioning from major burn injury. *Arch Phys Med Rehabil* 2007;88(12 Suppl 2):S18–23.
41. Pliskin NH, Capelli-Schellpfeffer M, Law RT, Malina AC, Kelley KM, Lee RC. Neuropsychological symptom presentation after electrical injury. *J Trauma* 1998;44:709–15.
42. Grossman AR, Tempereau CE, Brones MF, Kulber HS, Pembroke LJ. Auditory and neuropsychiatric behavior patterns after electrical injury. *J Burn Care Rehabil* 1993;14(2 Pt 1):169–75.
43. Morse MS, Berg JS, TenWolde RL. Diffuse electrical injury: a study of 89 subjects reporting long-term symptomatology that is remote to the theoretical current pathway. *IEEE trans Biomed Eng* 2004;51:1449–59.
44. Morse JS, Morse MS. Diffuse electrical injury: comparison of physical and neuropsychological symptom presentation in males and females. *J Psychosom Res* 2005;58:51–4.
45. Janus TJ, Barrash J. Neurologic and neurobehavioral effects of electric and lightning injuries. *J Burn Care Rehabil* 1996;17:409–15.
46. Barillo DJ, Harvey KD, Hobbs CL, Mozingo DW, Cioffi WG, Pruitt BA Jr. Prospective outcome analysis of a protocol for the surgical and rehabilitative management of burns to the hands. *Plast Reconstr Surg* 1997;100:1442–51.
47. van Zuijlen PP, Kreis RW, Vloemans AF, Groenevelt F, Mackie DP. The prognostic factors regarding long-term functional outcome of full-thickness hand burns. *Burns* 1999;25:709–14.
48. Sheridan RL, Baryza MJ, Pessina MA, et al. Acute hand burns in children: management and long-term outcome based on a 10-year experience with 698 injured hands. *Ann Surg* 1999;229:558–64.
49. Sheridan RL, Hurley J, Smith MA, et al. The acutely burned hand: management and outcome based on a ten-year experience with 1047 acute hand burns. *J Trauma* 1995;38:406–11.
50. Holavanahalli RK, Helm PA, Gorman AR, Kowalske KJ. Outcomes after deep full-thickness hand burns. *Arch Phys Med Rehabil* 2007;88(12 Suppl 2):S30–5.
51. Dodd, Nelson-Mooney K, Greenhalgh DG, Beckett LA, Li Y, Palmieri TL. The effect of hand burns on quality of life in children. *J Burn Care Res* 2010;31:414–22.
52. Farrell RT, Gamelli RL, Sinacore J. Analysis of functional outcomes in patients discharged from an acute burn center. *J Burn Care Res* 2006;27:189–94.

53. Jarret M, McMahon M, Stiller K. Physical outcomes of patients with burn injuries—a 12 month follow-up. *J Burn Care Res* 2008;29:975–84.
54. Klein MB, Lezotte DC, Heltshe S, et al. Functional and psychosocial outcomes of older adults after burn injury: results from a multicenter database of severe burn injury. *J Burn Care Res* 2011;32:66–8.
55. Tan WH, Goldstein R, Gerrard P, et al. Outcomes and predictor in burn rehabilitation. *JBCR* 2012;33:110–7.
56. Robert RS, Blakeney PE, Meyer WJ 3rd. Impact of disfiguring burn scars on adolescent sexual development. *J Burn Care Rehabil* 1998;19:430–5.
57. Meyer WJ, Russell W, Thomas CR, Robert RS, Blakeney P. Sexual attitudes and behavior of young adults who were burned as children. *Burns* 2011;37:215–21.
58. Mason ST, Esselman P, Fraser R, Schomer K, Truitt A, Johnson K. Return to work after burn injury: a systematic review. *J Burn Care Res* 2012;33:101–9.
59. Blakeney P. School reintegration. *J Burn Care Rehabil* 1995;16:180–7.
60. Staley M, Anderson L, Greenhalgh D, Warden G. Return to school as an outcome measure after a burn injury. *J Burn Care Rehabil* 1999;20(1 Pt 1):91–4; discussion 90.
61. Christiansen M, Carrougier GJ, Engrav LH, et al. Time to school re-entry after burn injury is quite short. *J Burn Care Res* 2007;28:478–81; discussion 482–3.
62. Horridge G, Cohen K, Gaskell S. BurnEd: parental, psychological and social factors influencing a burn-injured child's return to education. *Burns* 2010;36:630–8.
63. Esselman PC, Ptacek JT, Kowalske K, Cromes GF, deLateur BJ, Engrav LH. Community integration after burn injuries. *J Burn Care Rehabil* 2001;22:221–7.
64. Cromes GF, Holavanahalli R, Kowalske K, Helm P. Predictors of quality of life as measured by the Burn Specific Health Scale in persons with major burn injury. *J Burn Care Rehabil* 2002;23:229–34.
65. Pavoni V, Giancesello L, Paparella L, Buoninsegni LT, Barboni E. Outcome predictors and quality of life of severe burn patients admitted to intensive care unit. *Scand J Trauma Resusc Emerg Med* 2010;18:24.
66. van Loey ME, Nancy E, van Beeck EF, et al. Health-related quality of life after burns: a prospective multicenter cohort study with 18 months follow-up. *J Trauma Acute Care Surg* 2012;72:513–20.
67. Fauerbach JA, Lezotte D, Hills RA, et al. Burden of burn: a norm-based inquiry into the influence of burn size and distress on recovery of physical and psychosocial function. *J Burn Care Rehabil* 2005;26:21–2.
68. Xie B, Xiao SC, Zhu SH, Xia ZF. Evaluation of long term health-related quality of life in extensive burns: a 12 year experience in a burn center. *Burns* 2012;38:348–55.
69. Dyster-Aas J, Kildal M, Willebrand M. Return to work and health-related quality of life after burn injury. *J Rehabil Med* 2007;39:49–5.
70. Sheridan RL, Hinson MI, Liang MH, et al. Long-term outcome of children surviving massive burns. *JAMA* 2000;283:69–3.
71. Moi AL, Wentzel-Larsen T, Salemark L, Wahl AK, Hanesstad BR. Impaired generic health status but perception of good quality of life in survivors of burn injury. *J Trauma* 2006;61:961–8; discussion 968–9.
72. Altier N, Malenfant A, Forget R, Choinière M. Long-term adjustment in burn victims: a matched-control study. *Psychol Med* 2002;32:677–85.
73. Anzarut A, Chen M, Shankowsky H, Tredget EE. Quality-of-life and outcome predictors following massive burn injury. *Plast Reconstr Surg* 2005;116:791–7.
74. Druery M, Brown TL, La H Brown T, Muller M. Long term functional outcomes and quality of life following severe burn injury. *Burns* 2005;31:692–5.
75. van Baar ME, Polinder S, Essink-Bot ML et al. Quality of life after burns in childhood (5–15 years): children experience substantial problems. *Burns* 2011;37:930–8.
76. Low AJ, Dyster-Aas J, Willebrand M, Ekselius L, Gerdin B. Psychiatric morbidity predicts perceived burn-specific health 1 year after a burn. *Gen Hosp Psychiatry* 2012;34:146–52.
77. Roh YS, Chung HS, Kwon B, Kim G. Association between depression, patient scar assessment and burn-specific health in hospitalized burn patients. *Burns* 2012;38:506–12.
78. Willebrand M, Andersson G, Kildal M, Gerdin B, Ekselius L. Injury-related fear-avoidance, neuroticism and burn-specific health. *Burns* 2006;32:408–15.
79. Wikehult B, Willebrand M, Kildal M, et al. Use of health-care a long time after severe burn injury; relation to perceived health and personality characteristics. *Disabil Rehabil* 2005;27:863–70.
80. Kildal M, Willebrand M, Andersson G, Gerdin B, Ekselius L. Coping strategies, injury characteristics and long-term outcome after burn injury. *Injury* 2005;36:511–8.
81. Kimmo T, Jyrki V, Sirpa AS. Health status after recovery from burn injury. *Burns* 1998;24:293–8.
82. Stubbs TK, James LE, Daugherty MB, et al. Psychosocial impact of childhood face burns: a multicenter, prospective, longitudinal study of 390 children and adolescents. *Burns* 2011;37:387–94.
83. Parry I, Esselman PC; Rehabilitation Committee of the American Burn Association. Clinical competencies for burn rehabilitation therapists. *J Burn Care Res* 2011;32:458–67.
84. National Burn Care Review: Committee Report. Standards and strategy for burn care: a review of burn care in the British Isles. British Burns Association, London, England; 2001. Available at: [www.britishburnassociation.org/downloads/NBCR2001.pdf](http://www.britishburnassociation.org/downloads/NBCR2001.pdf).
85. Kildal M, Andersson G, Fugl-Meyer AR, Lannerstam K, Gerdin B. Development of a brief version of the Burn Specific Health Scale (BSHS-B). *J Trauma* 2001;51:740–6.
86. Willebrand M, Kildal M. Burn specific health up to 24 months after the burn—a prospective validation of the simplified model of the Burn Specific Health Scale-Brief. *J Trauma* 2011;71:78–4.
87. Kazis LE, Liang MH, Lee A, et al. The development, validation, and testing of a health outcomes burn questionnaire for infants and children 5 years of age and younger: American Burn Association/Shriners Hospital for children. *J Burn Care Rehabil* 2002;23:196–7.
88. Daltory LH, Liang MH, Phillips CB, et al. American Burn Association/Shriners Hospitals for children burn outcomes questionnaire: construction and psychometric properties. *J Burn Care Rehabil* 2000;21:29–9.
89. Kazis LE, Lee AF, Hinson M, et al. Methods for assessment of health outcomes in children with burn injury: the Multi-Centre Benchmarking Study. *J Trauma Acute Care Surg* 2012;73:S179–88.
90. Quinn T, Wasiak J, Cleland H. An examination of factors that affect return to work following burns: a systematic review of the literature. *Burns* 2010;36:1021–6.
91. Esselman PC, Askay SW, Carrougier GJ, et al. Barriers to return to work after burn injuries. *Arch Phys Med Rehabil* 2007;88:S50–6.



# Burn Wound Healing Outcomes

Adam J. Singer, MD,\* David H. Ahrenholz, MD,† Philip Chang, MD,‡  
Richard A. F. Clark, MD, PhD,§ Ryan Fey, MD,|| Phil Fidler, MD,¶  
Warren Garner, MD,# David Greenhalgh, MD,\*\* Shari Honari, RN, BSN,††  
Larry Jones, MD,‡‡ Richard Kagan, MD,§§ John Kirby, MD,||||  
Jeannie Leggett, RN, BSN,¶¶ Nicholas Meyer, MD,## Cynthia Reigart, RN, BSN,\*\*\*  
Karen Richey, RN,††† Lior Rosenberg, MD,‡‡‡ Joan Weber, RN, BSN, CIC,§§§  
Brad Wiggins, RN, BSN,||||| Steven T. Boyce, PhD¶¶¶

Development of metrics for burn care, including healing of skin wounds during the acute phase of treatment, is essential in an environment of decreasing resources and increasing interest in quality and accuracy of medical information. Advantages of consensus metrics include: tracking of trends in care; consistency of care; and correlation of treatment with medical outcomes. For cutaneous burn wounds, these advantages are confounded by factors that contribute to the heterogeneity of burn wounds, including but not limited to: TBSA of injury, depth of injury (partial or full thickness), cause, patient-dependent factors such as age, sex, and comorbidities, anatomic site, and time between injury and treatment. Similar factors contribute to complex injuries from trauma, and allow for risk adjustment of individuals in the population, who otherwise may be outliers to the statistical mean of the entire population.<sup>1-3</sup> Despite these confounding factors, certain common definitive events are necessary to accomplish healing of a burn wound, including: accurate diagnosis of burn

depth, debridement or excision of devitalized tissue, dressing or grafting of the prepared wound bed, and assessment to determine wound closure. In the absence of confounding factors or comorbidities, wound closure is one of the key criteria for discharge from acute care whether in hospital, or ambulatory care. Not surprisingly, these metrics for wound healing have been used repeatedly in the assessment of developing therapies for wound care. In response, review by the FDA of novel therapies has led to Guidance for Industry: chronic cutaneous ulcer and burn wounds—developing products for treatment.<sup>1</sup> With reference to cutaneous burns, this Guidance considers hemodynamic resuscitation, management of comorbidities, timely burn debridement and excision, wound closure, management of wound infection, pain control, nutritional support, measures to inhibit excessive scar formation, and rehabilitation, including passive range of motion when burns overlie joints. Other burn societies, most recently the Australia–New Zealand Burn Association, have also recognized the need for metrics of quality in burn care,<sup>4-7</sup> the need to accumulate data from the practicing community, definition of clinical criteria for data collection, risk adjustment to compensate for variability in clinical populations, and data validation for use. In this context, the participants in the Wound Healing Breakout Session of the Burn Quality Consensus Conference discussed metrics for evaluation of quality in healing of burn wounds. Particular focus was given to diagnosis of burn depth, debridement or excision of devitalized tissue, wound infection, and wound closure. Each of these aspects of burn wound healing will be reviewed as a potential metric for prospective capture and trending in the American Burn Association TRACS/National Burn Registry to allow tracking of quality of burn care. Whereas burn wound healing involves a prolonged process that starts immediately after injury and may continue for many months or years, this consensus statement will focus on the early phase of burn wound healing

From \*Stony Brook University, Stony Brook, New York; †Regions Hospital Burn Center, Minneapolis, Minnesota; ‡Massachusetts General Hospital/Shriners Hospital for Children, Boston; §State University of New York at Stony Brook; ||Burn Center, Hennepin County Medical Center, Minneapolis, Minnesota; ¶Washington Hospital Center Burn Center, District of Columbia; #Los Angeles County & University of Southern California Burn Center; \*\*Burn Center, Shriners Hospital for Children, Sacramento, California; ‡‡Burn Center, Ohio State University Wexner Medical Center, Columbus; §§Shriners Hospital for Children & University Hospital Burn Center, Cincinnati, Ohio; ||||Burn Center, Washington University School of Medicine, St. Louis, Missouri; ¶¶Burn Center, Loyola University Medical Center, Maywood, Illinois; ##Burn Center, Columbia St. Mary's Milwaukee Campus, Milwaukee, Wisconsin; \*\*\*Crozier Chester Medical Center, Upland, Pennsylvania; †††Burn Center, Arizona Burn Center at Maricopa Medical Center, Phoenix; ‡‡‡Soroka Medical Center, Ben-Gurion University, Beer-Sheva, Israel; §§§Burn Unit, Shriners Hospital for Children, Boston; |||||Burn Center, University of Utah Hospital, Salt Lake City; ¶¶¶University of Cincinnati Medical Center, Cincinnati, Ohio.  
Address correspondence to Adam J. Singer, MD, Department of Emergency Medicine, Stony Brook University, HSC L4-080, 8350 SUNY, Stony Brook, New York 11794-8350.

during the first few weeks up to a month. Because of the obvious importance of wound closure in the healing process, wound closure should be considered definitive to any burn care program. Burn wound infection is also of utmost importance because it can lead to burn injury progression or conversion of a superficial burn to a deeper wound. Microbial contamination in burn wounds may also result in systemic infection or sepsis, leading to increased morbidity and mortality. Another important element that measures the quality of care related to the early phase of burn wound healing is the success of autografting after excision of deep burns. Thus, the need for additional grafting or regrafting after a failed first attempt should be measured. The following summary outlines the metrics developed by the Wound Healing Breakout Session Group:

1. Time to burn eschar removal,
2. microbial bioburden or presence of infection in burn wounds,
3. time to wound closure, and
4. failure of, and need for additional autografting of prepared wounds.

## DEBRIDEMENT OR EXCISION OF THE BURN ESCHAR

### How It Meets Clinical Care Quality Outcomes

Among the most direct and effective interventions for reduction of risks from cutaneous burns is removal of the burn eschar.<sup>8–11</sup> Devitalized skin is a rich medium for microbial growth, and also is known to promote inflammation by release of cytokines and growth factors from injured or lysed skin cells.<sup>12–14</sup> Consequently, practices for care of burn wounds have favored early and complete removal of the burn eschar, but variability in the burn community is recognized, and data are not available.

### Proposed Metric for the TRACS Database

Because of the impact of timely removal of the burn eschar on wound closure and scarring, the proposed outcome measure regarding excision of the burn eschar is: Time (in days) from occurrence of the burn injury to complete (>95%) removal of the burn eschar.

## BURN WOUND INFECTION

### How It Meets Clinical Care Quality Outcomes

The ability of the burn wound to heal is inextricably linked to the presence or absence of infection in the wound bed. All burn wounds have microorganism

colonization, which may include bacteria, fungi, or viruses. However, the presence of these microorganisms does not indicate a wound infection. Wounds require constant surveillance to determine whether there are any changes that indicate the evolving development of infection.<sup>15,16</sup> In the preexcisional era of burn care, wound infection was diagnosed as *invasive* when bacteria or fungi caused early separation of the eschar layer and subsequent systemic sepsis. This type of wound infection is not often seen in the excisional era of burn wound care as most burn surgeons excise the deep burn followed by skin grafting before bacterial invasion occurs.

### Definitions and Measurement of Wound Infection

Definitions of wound infection have received extensive consideration as standards in care have advanced. Definitions for surveillance of burn wound infections were proposed in an American Burn Association Consensus Panel Publication on infections and sepsis after burn injuries<sup>15</sup>; the authors emphasized the importance of microbial surveillance. The recommendations of that conference included definitions of wound colonization, wound infection, invasive infection, cellulitis, and necrotizing infection including fasciitis. General definitions for burn wounds were also described in a report of the Centers for Disease Control and National Healthcare Safety Network.<sup>16</sup> Each of these reports provided definitions that have been harmonized in this article to characterize and differentiate invasive and noninvasive infections of burn wounds.

Presence of *invasive* burn wound infection may be defined as:

Infection occurring in a deep partial-thickness or full-thickness burn wound, associated with a change in burn wound appearance or character, such as rapid eschar separation or dark brown, black, or violaceous discoloration of the eschar; requires surgical excision of the burn and treatment with systemic antimicrobials; and may be associated with any of the following:

- a. Inflammation (such as edema, erythema, warmth, or tenderness) of surrounding uninjured skin;
- b. Histopathologic examination of the burn biopsy specimen showing an invasion of the infectious organism in adjacent viable tissue;
- c. Isolation of the organism from a blood culture in the absence of other identifiable infection;
- d. Systemic signs of infection such as hyperthermia, hypothermia, leukocytosis, tachypnea, hypotension, oliguria, hyperglycemia



at a previously tolerated level of dietary carbohydrate, or mental confusion.

What is more commonly seen is a *local or noninvasive* wound infection in a healing partial-thickness or grafted full-thickness injury, which can cause delayed healing or failure of the skin graft. Presence of noninvasive (local) burn wound infection may be defined as:

Burn wounds that have a purulent exudate that is culture positive (if performed), requires a change in treatment (which may include a change or addition to antimicrobial therapy, the removal of wound covering, or an increase in the frequency of dressing changes); and at least one of the following:

- a. Loss of synthetic or biologic covering of the wound;
- b. Changes in wound appearance, such as hyperemia;
- c. Erythema in the uninjured skin surrounding the wound;
- d. Systemic signs, such as hyperthermia or leukocytosis.

Microorganisms responsible for these infections include bacteria, fungi, or viruses. Bacteria include gram-positive organisms such as *Staphylococcus aureus*,  $\beta$ -hemolytic *Streptococcus group A*, or *Enterococcus* species (including vancomycin-resistant enterococci). Gram-negative organisms include non-enteric organisms such as *Pseudomonas aeruginosa* and *Acinetobacter baumannii* or enteric organisms such as *Klebsiella* species, *Escherichia coli*, or *Enterobacter* species. Yeasts include the *Candida* species and are generally part of the body's normal flora. Environmental fungi, of which the most common are the *Aspergillus* species, can cause life-threatening, invasive infection and extensive tissue loss. Viral infection, most commonly *Herpes simplex virus*, is less frequent.

Of increasing importance are the antimicrobial resistance patterns identified in many of the bacterial organisms, which may affect the effectiveness of prevention and treatment efforts. Specific organisms of concern include methicillin-resistant *S. aureus*, vancomycin-resistant *Enterococcus*, and multiple-drug-resistant *A. baumannii* and *P. aeruginosa*. In recent years, the frequency of identifying these organisms has increased and several strains of *Acinetobacter* and *Pseudomonas* have been found to be resistant to all tested antimicrobials except colistin.

### Proposed Metric for the TRACS Database

Because of the impact of burn wound infection on wound closure and scarring, the proposed outcome measure are:

1. Occurrence of invasive burn wound infection.
2. Occurrence of noninvasive burn wound infection.

## WOUND CLOSURE

### How It Meets Clinical Care Quality Outcomes

Wound healing is a complex yet highly regulated process that comprises several overlapping phases including inflammation, new tissue formation, and remodeling.<sup>17</sup> One of the earliest and most important phases of wound healing is wound closure, which is generally defined as complete wound reepithelialization or reestablishment of the outermost epidermal layer, the stratum corneum. Wound closure reestablishes a microbial barrier, reducing the risk of infection and limiting evaporative fluid losses. Early wound closure may also affect the ultimate healing of burns, their function, and appearance. Multiple studies have shown that burns that reepithelialize earlier are less likely to scar, possibly because of a reduction in inflammation and granulation tissue formation.<sup>18</sup> A wide body of evidence has demonstrated that superficial burns that heal or close within 2 to 3 weeks usually resolve without hypertrophic scarring or functional impairment.<sup>19</sup> In contrast, deep burns that fail to heal within 3 weeks frequently lead to hypertrophic scarring and functional impairment.<sup>20</sup>

### Definition and Measurement of Wound Closure

Despite the importance of wound closure, there is no standard, validated method used to measure wound closure. Anatomically, wound closure is defined by reestablishment of a neoepidermis that completely covers the wound. From a physiologic standpoint, wound closure is characterized by reestablishment of the barrier function as defined by a reduction in water vapor transmission, and/or a decrease in the surface hydration of the skin.<sup>21,22</sup> Although the anatomy and physiology of the skin are interrelated, anatomic restoration of the epidermis generally precedes physiologic restoration of the barrier by days to weeks.<sup>23</sup>

The prevailing standard for complete wound reepithelialization is histologic analysis of tissue specimens.<sup>24,25</sup> A major limitation of this method is that it is invasive, exposing the patient to pain and the risk of infection and scarring from the biopsy itself. Histologic analysis may also be subject to sampling bias, because it only represents the wound site biopsied, and it may not be representative of the entire wound. Additionally, sample preparation can sometimes inadvertently remove the fragile neoepidermis.

Thus wound closure is generally determined by non-invasive assessments of the skin surface, which examine the entire wound area.<sup>26</sup>

There is no standard clinical definition of wound reepithelialization, and it is often presumed that experienced clinicians have good interobserver agreement. The Wound Healing Consensus Work Group suggests that a wound is closed when it no longer readily transmits water, no longer needs dressings or bandages, is dry to the touch, and more pink or opalescent than red or transparent. One simple way to determine whether the wound surface is dry is to blot it with a tissue paper and see if the paper absorbs moisture. A recent study in a porcine burn model found high interobserver agreement of clinicians in determining clinical wound reepithelialization based on photos, but there was poor agreement between the clinical assessment and the histologic assessment questioning the validity of clinical assessment in the porcine model.<sup>27</sup> No similar study in humans was found, and it is unclear whether results in swine correlate with those in humans.

Several noninvasive methods have been used to assess the anatomical and functional integrity of the wound. Anatomical integrity can be assessed using either high-frequency ultrasound or optical coherence tomography.<sup>28-30</sup> However, both these methods are still experimental and have not been validated on a large scale. Furthermore, they are unlikely to be widely available to clinicians, limiting their broad applicability. Barrier properties of the skin can be measured noninvasively by one of two methods: electrical resistance and water vapor transmission. These properties are assessed in dermatologic practice with instruments that are validated and calibrated for human skin.<sup>31</sup> These instruments may be considered for measurements of healing in burn wounds, but impose a cost and requirements for training.

### Proposed Metric for the TRACS Database

Wound closure can be summarized more simply by one of two methods. With daily wound assessment, the approximate time to complete closure can be determined. If wounds cannot be assessed frequently, the percentage of the burns that are reepithelialized or closed at specific time points (3 or 4 weeks) may be determined. In order to limit the number of burn metrics, the panel proposed using the *time to complete wound closure in days* as the ideal quality metric for wound closure. Because some patients will be discharged before complete wound closure, we propose measuring the size (TBSA) of open wounds at hospital discharge as an alternative metric of wound

closure. Although no recommendations for benchmarking are proposed here, data collection might allow eventual optimal quality standards. The proposed outcome measures for wound closure are:

1. Time (in days) to complete (>95%) wound closure
2. Size (TBSA) of open wounds at the time of hospital discharge.

## AUTOGRAFTING OF DEEP BURNS

### How It Meets Clinical Care Quality Outcomes

With regard to large deep burns (ie, >20% TBSA), the Consensus Work Group recognized that comorbidities and limited availability of donor skin might complicate and protract wound closure. Therefore, metrics for large superficial and small deep burns may not be reliable for larger deep burns. Rather, as a metric for whether or not the treatment of large, excised burns is effective, the panel believed that failure of autograft procedures that require regrafting provides a valid measure of quality. This metric would be applied to grafting of burn wounds, regardless of whether the graft was with donor skin, engineered skin, or cell therapies. The metric would not be applied to healing of donor sites for skin autograft because they are surgical wounds, not burns. The committee also recognizes that the ability of a graft to take is dependent on multiple patient, environmental, and practitioner factors that need to be taken into account when considering why a particular graft failed to take.

### Proposed Metric for the TRACS Database

Because of the fact that failure of autografting delays healing and negatively affects patient outcome the proposed outcome measure regarding closure of deep excised burn wounds is: occurrence of regrafting of any autografted site.

## GAPS IN KNOWLEDGE AND OPPORTUNITIES FOR RESEARCH

After specification of the metrics for wound healing, gaps in knowledge that provide opportunities for prospective research were addressed. The Consensus Work Group identified four topics:

- A. To develop and test metrics for burn wound healing.
- B. To include wound treatment of outpatients as part of the data collection, because data in the National Burn Repository includes only inpatients.

- C. To evaluate whether best practices and outcome metrics correlate with less scar, or less grafting.
- D. To determine whether or not risk adjustments for mortality<sup>3</sup> are applicable to wound closure.

## REFERENCES

- US Food and Drug Administration. Guidance for industry: chronic cutaneous ulcer and burn wounds—developing products for treatment. Fed Regist 2006;65:39912.
- Steinvall I, Fredrikson M, Bak Z, Sjöberg F. Mortality after thermal injury: no sex-related difference. J Trauma 2011;70:959–64.
- Kaufman MS, Graham CC, Lezotte D, et al. Burns as a result of assault: associated risk factors, injury characteristics, and outcomes. J Burn Care Res 2007;28:21–8; discussion 29.
- Watterson D, Gabbe BJ, Cleland H et al. Developing the first Bi-National clinical quality registry for burns—lessons learned so far. Burns 2012;38:52–60.
- Watterson D, Cleland H, Darton A, et al. Developing clinical quality indicators for a Bi-National Burn Registry. Burns 2011;37:1296–308.
- Buttemeyer R, Steen M, Henkel VD et al. Establishing a baseline for organisation and outcome in burn care—basic data compiled by German burn centres, 1991–2000. Burns 2004;30:115–20.
- Helvig EI, Upright J, Bartleson BJ, Kagan RJ. Development of burn outcomes and quality indicators. A project of the ABA Committee on Organization and Delivery of Burn Care. J Burn Care Rehabil 1995;16(2 Pt 2):208–11.
- Hunt JL, Sato R, Baxter CR. Early tangential excision and immediate mesh autografting of deep dermal hand burns. Ann Surg 1979;189:147–51.
- Warden GD, Saffle JR, Kravitz M. A two-stage technique for excision and grafting of burn wounds. J Trauma 1982;22:98–3.
- Demling RH, LaLonde C. Early burn excision attenuates the postburn lung and systemic response to endotoxin. Surgery 1990;108:28–5.
- Mosier MJ, Gibran NS. Surgical excision of the burn wound. Clin Plast Surg 2009;36:617–25.
- Church D, Elsayed S, Reid O, Winston B, Lindsay R. Burn wound infections. Clin Microbiol Rev 2006;19:403–34.
- Boyle J, Roberts FJ, Snelling CF, Boileau L, Gelfant B. Rapid, simple, and inexpensive method to rule out bacterial invasion of fat subjacent to full-thickness burn eschar. J Burn Care Rehabil 1985;6:402–7.
- Dressler DP, Skornik WA. Eschar: a major factor in postburn pneumonia. Am J Surg 1974;127:413–7.
- Greenhalgh DG, Saffle JR, Holmes JH 4th, et al; American Burn Association Consensus Conference on Burn Sepsis and Infection Group. American Burn Association consensus conference to define sepsis and infection in burns. J Burn Care Res 2007;28:776–90.
- Horan TC, Andrus M, Dudeck MA. CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting. Am J Infect Control 2008;36:309–32.
- Singer AJ, Clark RA. Cutaneous wound healing. N Engl J Med 1999;341:738–46.
- Housinger TA, Warden GD, Lang D et al. The use of sheet skin grafts in pediatric burn patients. Proc Amer Burn Assn 1991;23:32.
- Kagan RJ, Warden GD. Management of the burn wound. Clin Dermatol 1994;12:47–6.
- Chan QE, Harvey JG, Graf NS, et al. The correlation between time to skin grafting and hypertrophic scarring following an acute contact burn in a porcine model. J Burn Care Res 2011;33:43–8.
- Boyce ST, Supp AP, Harriger MD, Pickens WL, Wickett RR, Hoath SB. Surface electrical capacitance as a noninvasive index of epidermal barrier in cultured skin substitutes in athymic mice. J Invest Dermatol 1996;107:82–7.
- Goretsky MJ, Supp AP, Greenhalgh DG, Warden GD, Boyce ST. Surface electrical capacitance as an index of epidermal barrier properties of composite skin substitutes and skin autografts. Wound Repair Regen 1995;3:419–25.
- Mustoe TA, Gurjala A. The role of the epidermis and the mechanism of action of occlusive dressings in scarring. Wound Repair Regen 2011;19 (Suppl 1):s16–21.
- Clark RAF. Wound repair: overview and general considerations. In: Clark RAF, editor. The molecular and cellular biology of wound repair. New York: Plenum Press; 1996. p. 3–50.
- Keast DH, Bowering CK, Evans AW, Mackean GL, Burrows C, D'Souza L. MEASURE: a proposed assessment framework for developing best practice recommendations for wound assessment. Wound Repair Regen 2004;12 (3 Suppl):S1–17.
- Barone S, Paoli A, Razonale AV. Assessment of chronic wounds by three-dimensional optical imaging based on integrating geometrical, chromatic, and thermal data. Proc Inst Mech Eng H 2011;225:181–93.
- Singer AJ, Hirth D, McClain SA, Clark RA. Lack of agreement between gross visual and histological assessment of burn reepithelialization in a porcine burn model. J Burn Care Res 2012;33:286–90.
- Badea R, Crişan M, Lupşor M, Fodor L. Diagnosis and characterization of cutaneous tumors using combined ultrasonographic procedures (conventional and high resolution ultrasonography). Med Ultrason 2010;12:317–22.
- Singer AJ, Wang Z, McClain SA, Pan Y. Optical coherence tomography: a noninvasive method to assess wound reepithelialization. Acad Emerg Med 2007;14:387–91.
- Fabia R, Groner JI. Advances in the care of children with burns. Adv Pediatr 2009;56:219–48.
- Bailey SH, Oni G, Brown SA, et al. The use of non-invasive instruments in characterizing human facial and abdominal skin. Lasers Surg Med 2012;44:131–42.